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ON THE ORIGIN OF THE FLOCKING HABIT OF MIGRATORY BIRDS

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IT is a noteworthy fact that many species of birds which take long migratory journeys make these movements in large flocks. The same is true to a less extent of the species which makes long daily flights for food. The origin of this flocking habit is not completely explained by the three ordinary theories, which neglect two most important considerations. These theories attribute the formation of the flock to the companionship which it affords, to the experience of old birds that know the sign posts of the journeys and hence lead the way, and to that protection against enemies, which may be secured by numerical strength; but two other protective features, of prime significance, are here overlooked. In the first place, the large flock automatically, by its numbers, maintains the proper direction of migration; secondly, and just as automatically, in the case of many large birds, the flock is warned and protected against its enemies by its form, or arrangement. The importance of these two automatic methods of protection is readily brought out by a consideration of the influences which tend to deviate the flock from its true course, on the one hand, and by a study of the actual groupings of birds in migratory flocks on the other.

Automatic Protection of a Large Flock

The chief causes of errors relative to direction of flight to which a single migrating bird is subject, are:

(*a*) *Confusion* with respect to the proper direction of flight.
(*b*) Effect of heavy winds or thick fogs acting as a temporary confusing factor while a flock is migrating.
(*c*) Gradual deviation from the proper course due to unequal wing power.

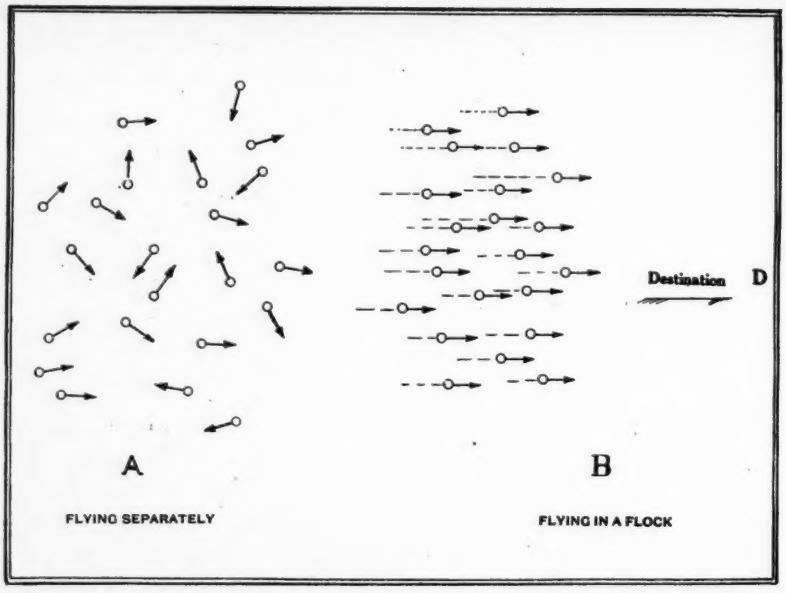

FIG. 1. In the left-hand diagram, *A*, the arrows are intended to represent birds and the directions in which each individual would fly *if alone*. Thus they indicate the amount of confusion of each bird with respect to the true destination *D*. In the right-hand diagram *B*, the birds are represented flying *in a flock*, the errors of orientation having been *averaged* by mutual reaction as indicated by the parallel arrows.

The large flock seems to eliminate these causes of error to a considerable extent, therefore it is probable that the origin of the flocking custom is largely due to the fact that it is protective.

The explanation suggested by the author to account for the flocking habit is as follows:

THE DIRECTION ERRORS OF THE INDIVIDUALS OF THE FLOCK ARE AVERAGED

If, for example, in the case of a migrating flock, there are any individuals that are confused in their bearings with respect to the direction of their destination, and there must be many that are more or less confused, some erring toward the right, some toward the left, the errors of the individuals of the flock are *automatically averaged and corrected by imitation, and by mutual reaction by those same individuals.*

According to this hypothesis, birds flying in a flock will follow the direction which may be called the mean flight direction of the flock. The idea is illustrated by a diagram. In Fig. 1, *A, the arrows* attached to circles are meant to represent the directions that the individual birds of a migrating flock would take, for example, after resting on an open sea, and arising to fly to an intended destination, *D,* (Fig.), provided *each individual was required to migrate alone from that moment.* The assumption is made that most of the birds are confused with respect to

the correct orientation to a greater or less extent, which is obviously the fact, although the confusion may be very slight in some cases. In Fig. 1, *B*, the direction in which the birds will actually move *when in flight as a flock* is indicated by the parallel arrows. Thus in Fig. 1, *B*, the mutually related influence of the individuals prevents the dispersion that would occur as indicated by the direction of the arrows in Fig. 1, *A*. The averaging of the errors that take place, as indicated in *B*, is approximately governed by mathematical certainty, and as a matter of fact, in the drawing Fig. 1, *B*, the flight direction was determined by taking the mean of all the directions indicated by the arrows in "*A*."

Each bird is affected by the averaging of flight directions due to the mutual reaction of the individuals, and the reaction prevents false starts. As an extreme case of this correcting influence, consider a flock of birds proceeding northward after resting on an open sea in a fog; and suppose that one bird was so confused that it would have flown in the opposite direction (to the south) *if alone*. Then, in all probability, in spite of its individual inclination to fly south, this bird would be carried northward with the flock by the powerful principle of imitation.

It must be distinctly understood that this theory does not give an explanation of the sense of direction, but it does provide a mechanism which will prevent individuals of the flock from getting lost. The only assumption is that there are all degrees of right and wrong "bearings" among the individual birds of the flock.

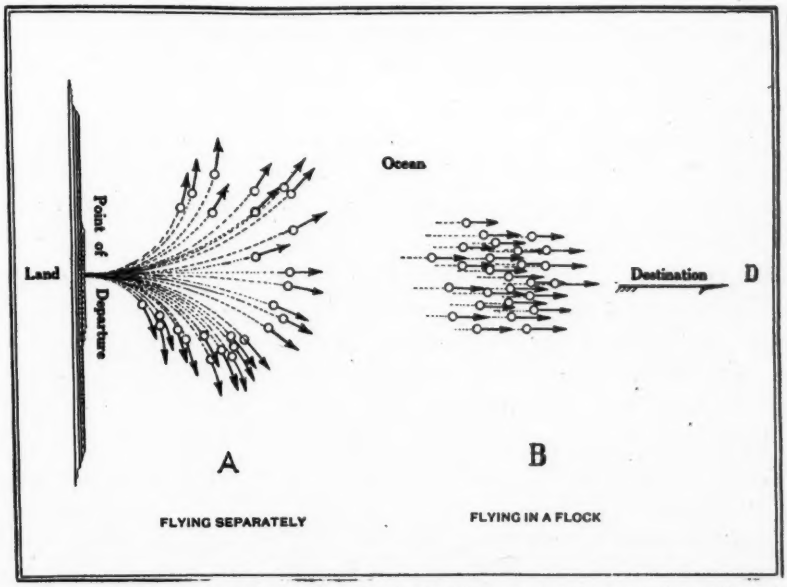

FIG. 2. The curved lines in the left-hand diagram *A* represent the paths which the birds would follow due to unequal unbalanced wing power, *if each was alone*. In the right-hand diagram, *B*, the arrows represent the birds *flying together* and the direction is the *mean* of all deviations and represents the flight direction towards *D* as corrected by mutual reaction.

FIG. 3. PLATOON FLOCK FORMATION, which is seldom observed; only the end birds can see towards the side. The field of view becomes *more obscured* as the number of birds *increase*. Non-protective.

The influence of every bird in the flock will affect the flight direction of the flying flock to some extent, yet they each produce their reaction, although perhaps not proportionately. It is probable that the birds in the front of the main part of the flock affect the direction greatest.

AVERAGING OF THE ERRORS OF FLIGHT DUE TO UNEQUAL WING POWER OF BIRDS

It is a well-known fact that when man is lost on a prairie or in a snowstorm he will often travel in a circle. The reason for this is that there is a *small constant deviation* of his course to the right or to the left. Small as this deviation may be, it is certain to throw him completely off his bearings, and not infrequently results in circling with fatal results. It is possible that a bird is subject to a similar deviation of its course, owing to the inevitable production of a *curved flight path* in case *one wing* of the bird is stronger than the other, the effect being similar to a man in a boat pulling at the right oar more powerfully than the left. Now the error of individual birds caused by a constant deviation of path due to unequal wing power, as well as the error due to mistaken "bearings," would be corrected if the errors of the individual birds in the flock are averaged while in flight by mutual reaction. Fig. 2, *A*, is meant to illustrate these deviations due to unequal wing strength, or to some similar cause, when single birds are proceeding, for example, from the mainland to a far distant island destination *D* (Fig. 2), and Fig. 2, *B*, the result when the birds are flying in a flock and when these deviations are averaged. It is of course evident that the averaged deviations might give a flight direction that is not exactly the right one, and a flock of birds might fly in a wrong direction if much confused. This is exactly what takes place; for occasionally flocks of geese and other species of birds have been known to become completely confused in a fog or during a stormy night. It is a very common occurrence for birds that are alone to become lost, as shown by the fact that so frequently single land birds alight, utterly confused, on vessels far out at sea.

The averaging of the errors of the direction of flight of the individuals is of course subconsciously done by birds and is quite automatic.

The principle of mutual reaction and its advantageous effect may be advanced as a reason for the massing of birds into flocks prior to the migratory journey, for if it is true that the flock formation has proved

helpful in migration, it is to be expected that the flocking together for the migration has slowly developed into a well-formed habit. Of course the desire for companionship and also the following of a leader must be additional reasons for the flocking of birds, but taken together or alone they do not seem to be a complete explanation.

FIG. 4. SINGLE-FILE FLOCK FORMATION, which is seldom observed. Only the first one or two in the line can see ahead. The field of view becomes *more obscured* as the number of birds *increase*. Non-protective.

THE NIGHT MIGRATORY CALL OF BIRDS

During the spring and autumn migrations at any time during the night in regions traversed by large and small wild fowl one can hear the curious night call of the passing birds. This call is generally regarded by ornithologists as a signal by which the birds may communicate from one to another. The night call, in the case of many species, is apparently only used while migrating, as it is also apparently nearly alike for certain species, although the matter has been little investigated. There are, however, sufficient reasons for the belief that the call has a special purpose, and that it may be a protective measure which aids in preventing the individual birds of small flocks from deviating from the correct migratory course. The call can be heard almost any time during the nights of April and May and also of August and September, the months when the greater number of birds make their migration in the temperate zone. The night call note appears to be different in many cases from the usual day cry of the birds and is peculiarly short and

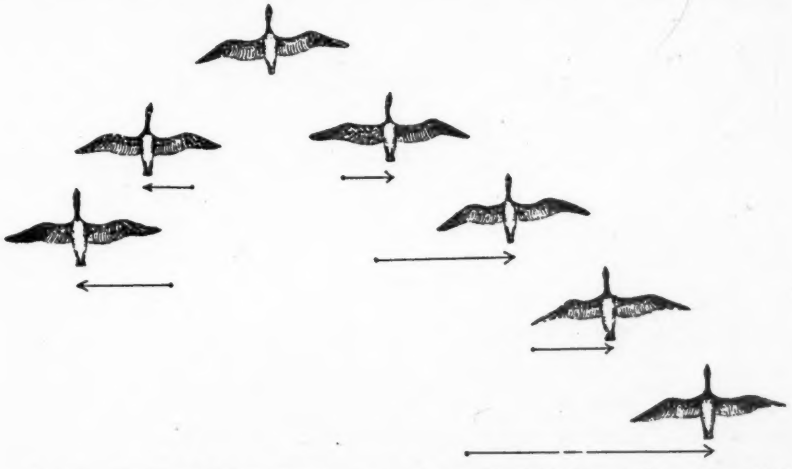

FIG. 5. ECHELON FLOCK FORMATION. The usual flight formation of large birds. *All birds* can see *ahead*, and *towards one side*, making the best arrangement for protection. The protective efficiency of the formation *is little affected by an increase* in the number of birds of the flock.

sharp. If the call of any particular individual bird is listened for, it appears to be repeated almost systematically every few hundred yards as the bird travels on its journey. In the absence of some proof of the true significance of the call note, an explanation can only be a hypothetical one, but it certainly appears as if the relation in space of one bird with its neighbors would be roughly maintained by this night call. If we imagine the birds distributed here and there in the air throughout the area through which the migration is taking place, the effect is that of a great flock flying, for example, southward, the individuals of which are widely separated. Each bird repeatedly signals to its neighbors and thus learns from its fellow travelers the general direction of migration.

Of course where there are many species in migrating, the velocity of flight of the various individuals would be different, and some birds would relatively advance and others fall behind, but a movement by a single bird diagonal in direction to the main movement of the migrating birds would at once be made evident by means of the sentry-like calls of the birds, both to the straying bird itself, and to the other alert individuals taking part in the migratory movement.

The importance of the mutual reaction of individual birds, set forth in a previous paragraph, as a means of preventing deviation from the correct course of flight, may apply to the night migration of many birds which are known to migrate singly, or in small flocks. That is, the mutual reaction of the individuals and small flocks, would then be communicated by the night call rather than by imitation through sight,

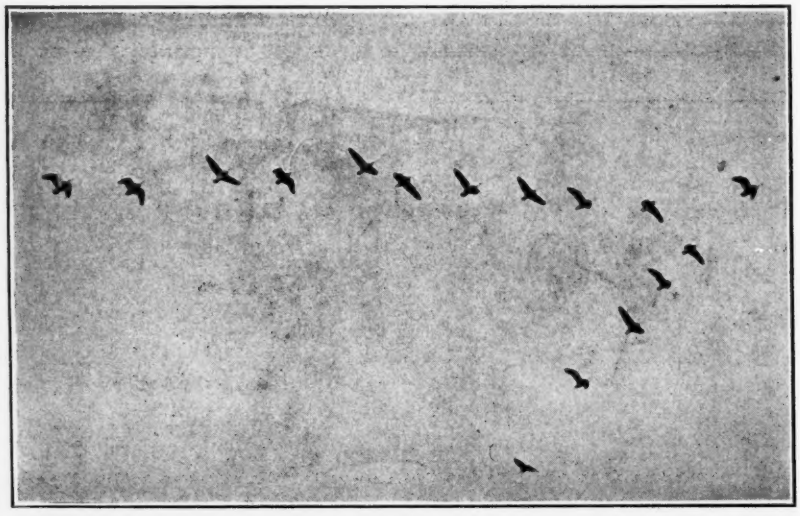

FIG. 6. FLOCK OF BLUE GEESE IN ECHELON FORMATION, photographed at the Mississippi delta by the Rev. H. K. Job. Note the acute angle of the flock and that for each goose the view is unobstructed in front and on the side.

or air pressure as in the closely formed flocks during the day. That countless numbers of birds migrate at night has been abundantly demonstrated and requires no proof.

The Protective Form of Certain Flight Formations

The flight formations of birds which fly in flocks vary greatly with different species, so varying is it that in many cases it is an identifying characteristic. Many small land birds fly in very compact groups, examples of which are the various species of blackbirds, grackels, cedar birds, finches, etc. Many water birds fly in compact flocks. Moreover, for many species there seems to be some general law regarding the size of the bird and the distance apart of the different individuals of the flock.

Probable Explanation of the Echelon Formation

The most distinctive formation is the echelon arrangement of flight and deserves special attention. Many of the larger water birds such as geese, many species of ducks, flamingoes, etc., practise this method of flight. The formation, according to one explanation, owes its origin to the fact that such an arrangement prevents swirls in the air produced by the wings of one bird from interfering with the next bird following. This may be true to some extent, but the explanation which the author holds as far more likely is that the formation is chiefly, if not wholly, a protective arrangement, and is, in fact, the only one in which the individual birds of the flock, if they are of considerable size, can see both forward and to the side at the same time, as demonstrated by the

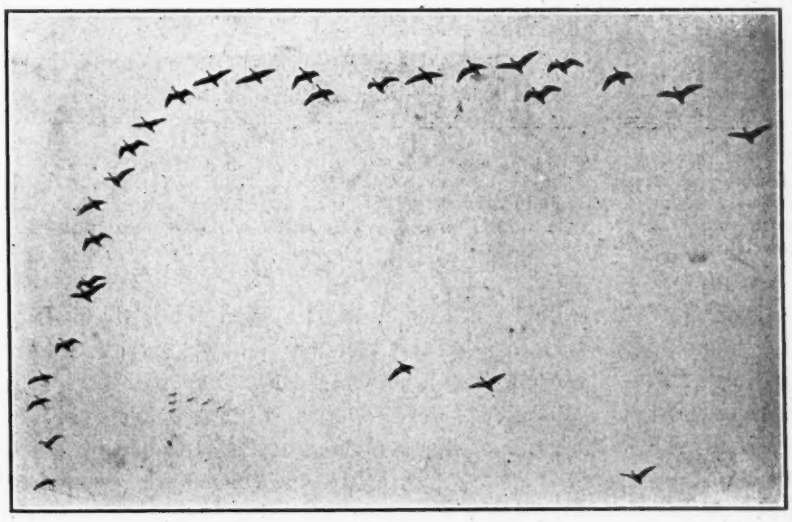

Fig. 7. Flock of Blue Geese in Echelon Formation, photographed by the Rev. H. K. Job. As in Fig. 6, for each goose, the view is unobstructed in front and at right angles to the line of flight.

illustrations, Figs. 3, 4, and 5, and also the exceptionally fine photographs, Figs. 6, 7 and 8, taken by the Rev. H. K. Job, state ornithologist of Connecticut, who kindly provided them for illustrating the present discussion.

It is probable that the echelon formation has come about partially by the fact that birds naturally follow one another by imitation. For example, suppose a flock of geese arises from a surface of water in one of

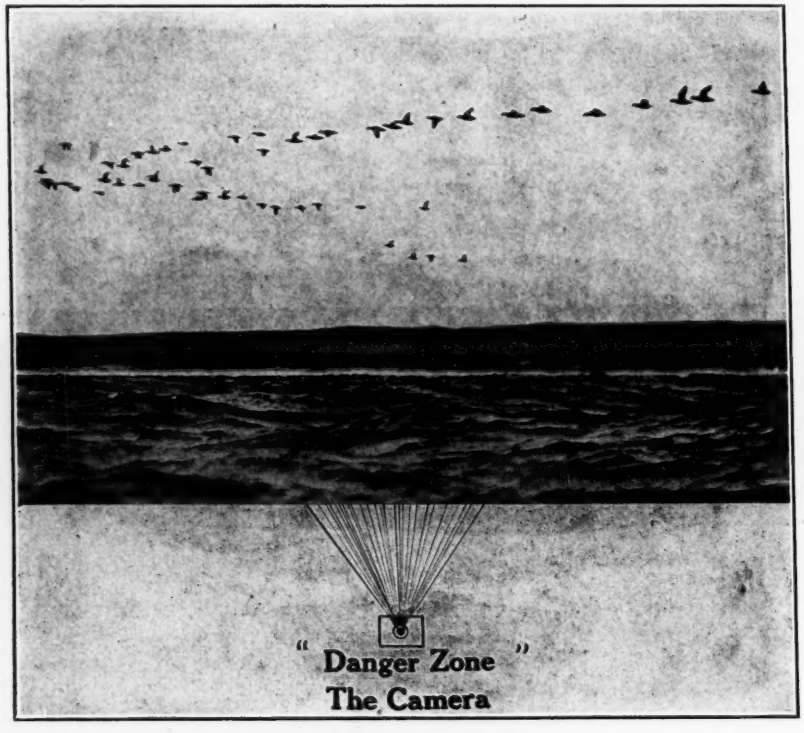

FIG. 8. FLOCK OF WHITE-WINGED SCOTERS IN ECHELON FORMATION, migrating off Manomet, Mass. Photographed by the Rev. H. K. Job from a row-boat. The heads of all the birds can be seen from the boat. At the moment the camera appears as the danger point to the birds. *Every eye on the boat side has an unobstructed view.*

their daily flights to their feeding ground; at first the individuals will be grouped together indiscriminately, many following those that are leading. Then, for example, the second bird in line will shift to the right or left to be able to *see ahead* as well as *to the side,* and so on down the line. While the mode of flight is now a well-formed habit, yet the process of producing the formation goes on to some extent each time a flock (of geese, etc.) begins a flight. The echelon formation is thus the one that will permit the greatest number of birds to see towards the chief danger zones, the front and the sides. Perhaps this explanation

has been given by others, but the author has not found it in other writings. Small birds that pursue an irregular flight (*i. e.*, undulating or fluttering) have an opportunity to see into the danger zones even when in a large flock; hence the necessity is lacking for the echelon arrangement of the individuals of a flock in such cases.

Among certain species of ducks a reverse echelon flight formation is observed, namely, the directions of flight is in the opposite direction to the point of the V. The reverse V is nearly as protective as the V. Since in this form also the *number of eyes* of the birds in the flock which cover the "danger zone" is at a maximum. The above hypothesis does not in any way conflict with the theory that geese will follow a leader, a theory which may or may not be true.

The facts presented above are taken as strong arguments for the conclusion that the origin of the flocking habit is due to its protective effects, and that particularly the echelon arrangement of flight has been evolved from the protection against enemies which it affords.

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WATER

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THALES, one of the Seven Wise Men, said:

Water is the element, the first principle of things.

There is no doubt that Thales thought he knew a great deal about water, but even the average man to-day probably thinks he knows much more. Yet, what does he know about it?

It would be difficult to overestimate its great value to the human race, and its far-reaching importance in matters scientific.

In its various forms it has been dealt with by some of the most eminent of scientists, and the subject, like the boundless ocean, is so wide that there are few branches of scientific research in which it does not claim attention.

First of all, what is its source? According to the astronomers and geologists, the earth is nothing more than a condensed and cooled portion of a vast nebula, which must have been similar to many now adorning the heavens. This nebula was a mass of self-luminous, gaseous matter, very highly heated. Of course, water, as such, could not exist in this, but was dissociated, or separated into its constituent parts, the two gases hydrogen and oxygen. Above a temperature of 2,000° C. or 3,632° F., these gases do not combine to form water, whereas the earth, in the molten, to say nothing of the gaseous condition, must have had a temperature hardly less than 6,000° C. However, the earth finally cooled sufficiently for the water to form as steam and then to condense to the liquid state.

For a long time, in fact until about 130 years ago, it was thought that water was an element. Aristotle named it as one of the four elements, earth, air, fire and water. This view of the composition of so-called matter held sway for several centuries. Even after the theory was broken up, water still remained as an element. It was not until 1781 that it was found to be a compound substance. Priestly, and likewise Lavosier, showed that when hydrogen is burned, water is the outcome. The ideas of the former, however, were in conformity with the phlogiston theory which held sway at that time. By the experimentation and study of later workers on this subject, this theory was overthrown and water was proved to be a combination of hydrogen and oxygen in the proportion of two parts by volume of the former to one part by volume of the latter, or by weight, 2.016 parts of the former to 16 of the latter. The proof is as follows: Known quantities of hydrogen

and oxygen are exploded and the water formed is weighed or the amount of each gas used is measured. Also water is decomposed by electrolysis and the hydrogen and oxygen thus formed (the only things formed) are measured.

The heat given off in the combination of the gases is enormous, indeed, it is the most exothermic of all chemical reactions, 67,500 calories or heat units being evolved in the combination of 16 grams of oxygen with 2.016 grams of hydrogen—a calorie is that amount of heat which will raise one gram of water 1 degree centigrade. In the absence of indifferent gases, or an excess of one of the reacting gases, the reaction is not only so violent as to raise the gases to the combination temperature, 2,000° C., but to carry them beyond to 2,844° C., at which temperature only about one third of the gases combine, the remainder doing so gradually as the temperature falls. Almost any non-reactive (catalytic), highly heated substance, such as platinum sponge, or wire, stone, porcelain, glass, etc., will bring about a combination.

An oxy-hydrogen blowpipe is an arrangement for utilizing this heat energy, by bringing the two gases together in such a way that they will produce a sharp, intensely hot flame. The apparatus is so fashioned that the gases are conducted separately through the exit where they are to be lighted, thus avoiding any possibility of explosion, which otherwise takes place, if they are mixed. By means of such a flame, a temperature of 2,000° C. can be obtained.

Having learned that water (at least in the form of its components) is older than even the earth itself, that its constituent parts existed practically at the beginning of things, and also that it is not an element, but built up of two gases combined in a definite proportion, let us now take up the substance itself and study it in its various forms. These are quite numerous, but may all be classified under three fundamental heads: gaseous, liquid, and solid water.

The fact that it can exist in these three states is not so remarkable, since it is possible to transform every known substance, elementary or combined (provided the latter do not decompose) into these three states of aggregation; but that the three should all be within the range of *ordinary* temperatures *is* rather extraordinary. There are only a few common substances of which this is true, *e. g.*, ammonia, benzene, etc. It will be seen, moreover, that water has a good many other noteworthy properties. As compared with other substances it is nearly always exceptional, and stands at the extremes.

Gaseous Water.—Steam and atmospheric water vapor belong in this category. It is not until we go to some of the arid desert regions of our earth that we realize the importance of the latter. Where there is no moisture in the atmosphere, there can be no clouds formed, and hence there can be no rain, which means, of course, that such a place must be

devoid of life; for example, the Sahara, the deserts of Asia, of western United States, etc. Yet the presence of moisture can be very disagreeable, as in hot, humid climates. The amount in the atmosphere varies considerably, depending upon the complex condition of climate and topography, therefore no general data can be given.

Steam.—The very word signifies the sublime, the wonderful! What could we do at present without it? How many thousands of mills, shops, locomotives, etc., derive their power from it? Power? Let us stop and consider—*1 gram of water in the form of steam occupies 1,700 times the space that a gram of water in the liquid form does.* Is it any wonder that steam is a mighty agent? If a sufficient quantity is confined and superheated, as was the case when the volcanic mountain of Krakatoa was almost completely annihilated, there is nothing that can withstand it.

According to the theory of kinetic energy, the molecules of all substances are in rapid motion, and at the surface of liquids, water in particular, there is a tendency for some of the rapidly moving particles to be thrown off into the atmosphere and to form vapor. Likewise, some of the vapor molecules pass back into the liquid again. When the tendency of each to pass into the other is exactly counterbalanced, we have what is called a state of equilibrium between the two phases. This tendency of the molecules to pass off into the atmosphere, even at lower temperatures, gives rise to a certain amount of pressure, called "vapor tension." The atmosphere, or any artificial pressure which may be applied, tends to overcome this. At every temperature only a certain amount of water vapor can exist under a given external pressure, viz., the vapor tension of water at that temperature. At that pressure you have a "saturated vapor." Stronger pressure causes liquefaction; reduced pressure, an increase of vapor.

Steam is that condition or phase of water which is stable at temperatures above 100° C., at ordinary atmospheric pressure (760 mm. mercury). At this temperature and pressure the vapor tension of the liquid water is so great that none of it can remain in the liquid state. Increased pressure tends to drive back the steam into the liquid state again, the temperature of boiling being increased directly in proportion to the temperature. Up to a certain temperature, the "critical temperature," 360° C., water can be made to remain in the liquid state by applying sufficient pressure. Above that it can exist only in the form of a gas, no matter how great the pressure. It is possible, by using a small enough quantity of water and a *sufficiently strong* apparatus, to determine the critical temperature and pressure by experiment.

The amount of heat absorbed in the transformation of a unit quantity, 1 gram, of water at 100° C., into steam, that is, its heat of vaporization, is 537 calories (this is exactly the same in amount as its

heat of condensation). It is easy to see, then, why it takes so long to boil away a large quantity of water. The amount of heat absorbed which is necessary to raise the water to its boiling point and keep it there is simply enormous. It may be said here that after the water once reaches the temperature 100° C., it remains there until the whole of the liquid boils away, even though the amount of heat applied is somewhat in excess of that required to keep it at the desired temperature.

Liquid Water.—Very much more interesting and important than any other form of water is liquid or "wet water." In this form it is the most fascinating of all chemical substances, besides being the most useful. In the first place it forms 75 per cent. of the human body and without it *nothing* could live. It covers about two thirds of the earth's surface to an average depth of about 12,500 feet. It is the best solvent known; as will be shown later, it is an essential to almost all chemical action. Here again life as well as nearly all branches of science would be at a standstill if it did not exist. It occurs as rain, fog, dew, river and ocean water, spring water, etc.

When the vapor of the atmosphere condenses around small particles of dust in the air, clouds are formed, or, if down near the surface, a fog. Whenever these small particles run together they produce drops which fall as rain. Dew is nothing more than water which has condensed out of the atmosphere on to cold objects. Only so much moisture can be held in the air at a given temperature if this is lowered, as would happen after the sun goes down, the dew separates out. If pure, water is an odorless, tasteless and in small quantities, colorless, transparent liquid. In bulk it becomes blue in color and very nearly opaque. It never occurs *pure* in nature, the nearest approach to it being rain-water after it has rained for some time (at first the rain gathers up a large amount of impurity from the atmosphere); and melting snow. Water can be readily purified by distillation. For ordinary purposes one distillation is enough, but for certain scientific work a special method of distillation must be resorted to. In this degree of purity it is almost a non-conductor of electricity.

Water is only slightly compressible. For every atmosphere (15 pounds per square inch) of additional pressure, it is made smaller by 0.0005 of its volume. The effect of pressure upon its freezing point is also exceedingly small—only 0.00757° C. lowering for each atmosphere. Nevertheless, it can be prevented from freezing by a pressure of 138 tons to the square inch at 1.11° C. Any further lowering of temperature requires a proportional increase of pressure. In passing from the liquid to the solid state there is an increase in volume equivalent to one eleventh that of the liquid.

The boiling point is affected to a much greater extent. Under a normal pressure of 760 mm., water boils at 100° C., or rather, this value

is arbitrarily assigned to it under these conditions, and all other values of temperature are referred to this and to the freezing point, 0° C., as standards. If the pressure is changed, the raising or lowering of the boiling point is directly in proportion.

Egg albumen coagulates only very slowly at temperatures below 100° C., and since the atmospheric pressure on the top of high mountains is quite a bit lower than at their foot, we see from the above why an egg takes so very much longer to cook at such elevations, if it cooks at all.

Water is a powerful refractor of light. This can be best shown by holding a stick in it in a slanting position, so that part of it protrudes above the surface. The stick appears to be bent. An interesting curiosity which makes use of this principle is the fish-eye camera, which makes things in front of it appear just as they would to a fish under water, that is, instead of a limited view of the scenery, or whatever it may be, everything within a radius of 180° is shown in the picture. The camera is a box filled with water; in the back is placed the plate, and the light enters through a small hole in the front.

Most substances, when dissolved in water, lower its freezing point. That is one reason why salt is used in the freezing mixture when making ice cream, the temperature of the ice salt mixture surrounding the can in a "freezer" often reaching a temperature of —21° C. In this connection it may be said that the stirring which is carried on serves two purposes; it brings the entire contents of the can into contact with the cold walls of it, which radiate the heat very rapidly to the outside; it likewise causes a more rapid crystallization of the contents, and in consequence makes the crystals much smaller.

Mention should also be made here of the undercooling which takes place when a solution is cooled. Instead of ice forming at the freezing temperature of the solution, by keeping it quiet and out of contact with the air, the solution will remain in the liquid state several degrees below that point. A small crystal of the solvent, or a sharp-edged body, or even a jar, will cause it to freeze suddenly.

Similar to this is a supersaturated solution, or one in which more of the substance is dissolved than it can ordinarily hold, a crystal of the dissolved substance, or the other treatments spoken of, causing crystallization.

Besides lowering the freezing point, dissolving a substance in a liquid also raises the boiling point. Much could be written concerning both phenomena but space does not permit. It is enough to say that the relationships established by a study of them are some of the most important of all science. Of course every substance has its own effect and the amount of each dissolved has to be taken into account as well.

When an acid, base or salt is dissolved in water, it is dissociated,

that is, the molecules of the substance are split up into two parts, each part being charged with equivalent quantities of opposite kinds of electricity. These charged particles are called ions, and a compound which yields ions is called an electrolyte; all others, such as sugar, for instance, are called non-electrolytes. Solutions of the former will easily conduct an electric current, while solutions of the latter will do so no more than the pure water itself. Of all common liquids which dissociate substances, water has the highest power. It is dissociated itself only to the very slightest extent.

A fact which can be explained only by the theory of electrolytic dissociation is, that whenever an acid in solution is acted upon by an equivalent quantity of a base in solution, both solutions being dilute, and no matter what the acid or base, the same amount of heat is liberated in the reaction. The only thing here which can and does take place is for the hydrogen ion, which is the essential part of the acid, to combine with the so-called hydroxyl ion, the essential part of the base, to form a definite quantity of water, the same in every case, and hence giving off the same quantity of heat. The other parts of the acid and base remain unchanged, as ions, in the solution. In concentrated solutions, other factors come into play which necessarily cause the amount of heat to be variable.

We see from the above that water instead of being a side issue in chemical reactions, as we have been prone to place it, is really the most important and most fundamental thing in them. Moreover, it is made up of what constitutes both acid and base and yet has not the slightest trace of the properties of either. It is perfectly neutral.

When a soluble solid, no matter how great its specific gravity, is placed in the bottom of a vessel and is covered with water, it will in time diffuse through the entire liquid until the whole is perfectly homogeneous, even though the force of gravity is pulling continually against it, tending to keep it at the bottom. Diffusion is said to be due to osmotic pressure, but as this has never been explained satisfactorily, we are about as far from answering the question as to its cause as if we had left it alone. All we know of osmotic pressure is, that if we separate two solutions of different concentrations by a membrane, water will pass through the membrane from the more dilute to the more concentrated solution, which, if the latter side is enclosed, will set up a pressure on that side. This is called osmotic pressure, and there are certain laws governing it. These have been thoroughly studied and have been shown to correspond exactly to the laws of gases, but the cause for the pressure is as yet unknown. Diffusion is not a property of water only, but of all liquids. However, it has been studied in the case of water more thoroughly than in any other.

Another property of all liquids which has a special interest where

water is concerned is surface tension. It is this property which causes a liquid to rise in a capillary tube and also aids in the formation of drops (pressure of the atmosphere likewise tending to reduce the liquid to the smallest, most stable geometric shape possible). It is due to capillarity that the minute blood vessels of living animals are supplied with blood, that a blotter sucks up ink, that moisture tends to come to the surface of the earth and that a good many other essential things of a similar nature take place. In fact we could not do without this important force.

Solid Water.—Here we have snow, hail, frost and ordinary ice.

Snowflakes are assemblages of minute crystals of ice formed from the aqueous vapor in the atmosphere. They vary in size from one fourteenth of an inch to one inch in diameter. The smaller ones are formed when the temperature is very low, but the larger ones not until it is near 0° C. They always assume a hexagonal shape and from each corner of the hexagon protrudes a ray at an angle of 60° to the ray on either side of it. This fundamental form is the same, no matter how much the crystals otherwise vary in shape.

Snow is only white to the eye because of the great refractive power of the crystals, which, when examined under the microscope, are seen to be transparent. It forms whenever a cold enough wave passes over a moist atmosphere, the water condensing out as crystals. Hail, on the other hand, is formed when the rain passes through a region of the atmosphere sufficiently cold to freeze it.

Just as the dew condenses out of the atmosphere on a summer night, on a winter night, when the temperature is below 0° C. frost forms. The action of frost as a geological agent need hardly be mentioned, it is so well known. Suffice it to say that it has played and continues to play a very important rôle in the changing of the earth's topography.

Water, when it cools, contracts until it reaches a temperature of 4° C., and then it begins to expand, slowly at first, until it very nearly reaches 0° C. and is about to freeze, then it increases very markedly and suddenly in volume. The specific gravity of ice is only 0.920, whereas at 4° C., pure water has a specific gravity of 1.000, that is, at 4° C., one cubic centimeter of pure water, in a vacuum, weighs one gram. Water is therefore used as a unit for specific gravity measurements. If water contracted all the way down to its freezing point, as most liquids do, in one cold winter every river, lake, etc., would be frozen up and would stay so, because of the ice being so much heavier than water and sinking to the bottom.

In freezing, water gives off a very large amount of heat, 79.06 calories for every gram of ice formed. The amount of heat liberated in freezing a gram of water, stating it in other words, is sufficient to raise the temperature of 79.06 times its weight of water from 0° C., to

1° C. Now we see why there is always a "warming up" just before a snowstorm.

When gases are allowed to expand suddenly, they cool themselves, taking heat from all surrounding objects. Also if a substance, like ammonia, which at ordinary temperatures is a gas, can be condensed by cooling and pressure to a liquid, and the pressure is removed, it will immediately begin to evaporate rapidly, and in so doing absorb a large amount of heat from everything around. Such a principle is used in the preparation of artificial ice.

Ice is often seen to have much dirt in it. If the water were stirred while freezing so that the crystals which separate are small, they would also be very nearly pure.

So much for solid, liquid and gaseous water. There are still one or two interesting things in connection with water, however, which do not bear directly on any one of these three heads.

Certain compounds have the power to crystallize with a greater or less amount of water—"water of crystallization," as it is called. Most of them can lose this water (or part of it) by heating them, and without detriment to the substances themselves. Examples of such are copper sulphate, sodium sulphate, alum, calcium chloride, etc. Some of these, like calcium chloride, if allowed to stand in the air, will attract moisture and become wet. They are said to be deliquescent. Others like sodium sulphate tend to lose their water of crystallization on standing open to the air. They are called efflorescent. There are still other compounds, called anhydrides, which take up water readily from the atmosphere, not as water of crystallization, but by so doing form a different compound, an acid. Phosphoric anhydride (phosphorus pentoxide) is an example of this kind, and it is the finest substance known for desiccating purposes. Dehydrated copper sulphate and calcium chloride likewise are extensively used.

Sugar, oxalic acid and a number of other substances lose water when being heated, but here the loss is quite a different one from that above. The compounds themselves are completely changed, showing that the water was in direct combination with them and that it was the fundamental part of them.

Many people know that water forms a large part of the human body and of the nourishment of the same, but few know what an enormous percentage of the whole this is. A human body weighing 150 pounds contains about 113 pounds of water (75 per cent., as was stated above), and requires daily for its sustenance, either as a liquid or combined with food, about 5.5 pounds of water. This equals more than half a gallon.

One can see from the following table from what source a large part of this water is derived:

	Per Cent.
Bacon	22
Eggs	65
Butter	11 to 16
Richest Milk	87
Cucumbers	97
Salmon	75
Beef	73
Cabbage	89
Potatoes	75
Cheese	25 to 50
Strawberries	90
Apples and Grapes	80

It would take volumes to tell of all the effects of water as a dynamic agent in geology—of the action of frost, of percolating waters, of rain, of waves, of rivers, glaciers, lakes, oceans, subterranean waters, etc., of all these and more on the exterior and interior of the earth. As justice can not be done to any one of these topics in a few words, they can only be mentioned here.

The prime importance of water to chemical reactions has already been spoken of above, but in conclusion, one or two examples will help to further show how really essential it is.

Concentrated sulphuric acid and metallic sodium will react with the most explosive violence if brought together in the presence of only a trace of water, but if proper precautions are taken to exclude every particle of moisture, drying them first and then bringing them together as quickly as possible, there will be no reaction whatever. The fuming of hydrochloric acid and ammonia in the presence of each other is proverbial in the chemical laboratory. They combine to form ammonium chloride, which appears in the form of a white cloud. Here again there is no combination, if the two are perfectly dry. Soda and tartaric acid (both solids) can be intimately mixed together, in solid form, without undergoing any reaction. But as soon as water is added, a tremendous effervescence takes place.

Many other cases might be cited, but these, as well as what has gone before, will, I hope, give some idea, at least, of the all importance of this wonderful yet common substance.

PSYCHOTHERAPY IN FOLK-MEDICINE

By Dr. ABRAM LIPSKY

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PSYCHOTHERAPY may look like a discovery of the twentieth century, but the truly remarkable thing about it is the extent to which it has been practised without being scientifically understood. It has been in the world since the remotest antiquity, nor has it ever left the precincts of civilization. A scholar spelling out an Assyrian inscription discovers a cure for rheumatism as follows: "Surround the patient with a circle of leavened meal, place his foot upon a reed-bearing dough, then put away the refuse-food. Take him seven time across the surrounding circle, saying 'Ea hath loosed, free the evil, Ea hath created, still the wrath, undo the knots of evil, for Ea is with thee! O Physician of the World! O Ninnissin! Thou art the gracious mother of the world, the leader of the underworld, the mistress of E-dubbo,'" etc. What is this but psychotherapy? A New England cure for rheumatism is to take a cat along to bed. That too is psychotherapy and rests on essentially the same principle.

The scientific person will say that these are interesting examples of heathen superstition, but that no one was ever cured by such means. That is just the question. In the light of our present knowledge, the probability is that both the Assyrian and the New England methods have worked—at least sometimes. Both are illustrations of the influence of thought upon the body. In the one case, faith of a religious nature dispels the physical symptoms; in the other, fear of the cat is probably the therapeutic distraction—or, as the psychologists call it, the "dissociation."

Popular psychotherapy has long known what science is only now finding out. The best known example of mind-cure is probably that of the toothache that ceases when the dental office is approached. If a man may cure his toothache by walking in the direction of a dentist's office, why may he not cure it by spitting into a frog's mouth, or scratching his gum with a nail and driving the nail into an oak tree, or pulling out with his own teeth the teeth of a dead man's skull, or solemnly repeating the lines:

> Christ passed by his brother's door,
> Saw his brother lying upon the floor,
> What aileth thee, brother?
> Pain in the teeth?

Thy teeth shall pain thee no more.
In the name of the Father, Son and the
Holy Ghost!

Why should it be more difficult to believe that toothaches have been cured by each and every one of these methods as promptly as by the sight of a dentist's forceps? The therapeutic agent in each case is the same. It is psychical, and we call it "suggestion."

But if a toothache can be cured by psychotherapy, why not the ague? That too has often been done. Can modern psychotherapy produce a prettier illustration of the method of auto-suggestion than this—described in an old Saxon medical book? We are told that the sick man wrote the words "Febra Fuge" (fly away, fever) on a piece of paper and, beginning with the last letter, cut off a letter each day. The fever abated day by day and when the letter "F" finally fell, the ague disappeared. Fifty others, besides the narrator, were cured the same year by this method!

As the virtue of a dose of medicine does not depend upon the kind of spoon in which it is conveyed to the patient's lips so, a different way of administering suggestion for the ague proves in New England to-day of equal potency with that described by the early English writer. The patient goes out with a friend and looks on while the friend cuts down willow rods corresponding in number to the hour of the day. Each rod must then be burnt singly and as the last one turns to ashes the distressing symptoms disappear.

Among the country people of modern England a variety of devices for circumventing the ague are known. If you peg a lock of your hair into an oak and give a sudden jerk with your head, your ague will be transferred to the oak. Or, to mention only one other, you may take nine or eleven snails, string them on a thread, saying with each slimy bead, "Here I leave my ague." Frizzle them over a fire and as the snails disappear, so will your ague.

Observe how the last method accords with modern scientific psychotherapy. The practitioners of the Emmanuel movement tell us, in "Religion and Medicine," that when giving one's self a verbal auto-suggestion, it is well to accompany the words with some action, however trifling and absurd—the absurdity of the action, in fact, being rather something in its favor. For example, when you say to yourself: "I put away all worry," you might put an old shoe out of sight and think of your worry as staying with the shoe. The snail cure for ague obviously anticipates these directions. It takes advantage, moreover, in a very cunning way of another psychological discovery—the hypnotic influence of bright light when stared at fixedly. Most people now-a-days are familiar with this phenomenon from their experience in staring at strongly illuminated stereopticon screens. They know how difficult it

is to keep awake—unless the lecture is unusually exciting. Now, suggestion is most effective on persons who are in a somnolent or hypnotic condition, and your credulous rustic, staring into the fire as the snails sizzle and repeating to himself, "Here I leave my ague," is performing a very pretty psychological experiment on strictly scientific lines.

Scientific psychotherapy has undoubtedly taken this hint of reinforcing verbal suggestion with a trivial action from popular practise. The device is perhaps best known in popular medicine as applied to the cure of warts. You strike the wart downwards three times with the knot of a reed as you make your auto-suggestion, or, you rub it seven times with the third finger of the left hand in the direction in which the sun moves; or, you wet your forefinger with saliva and stroke the wart in the direction of a passing funeral; or, you touch each wart with a pebble, place the pebbles in a bag and lose them—the finder getting the warts; or, you tie as many knots in a hair as you have warts and throw the hair away; or, you steal a piece of bacon, rub the wart and slip the bacon under the bark of an ash tree, thus causing the warts to disappear from your hand and appear on the bark; or, you get another, by hook or by crook, to count your warts, when they will pass over to him.

Let it not be supposed that the foregoing remedies are merely prescriptions, but not cures. Innumerable experiments have been made with them by persons who sincerely believed in their efficacy, and the evidence of their success is as abundant as that of the success of more academic methods. The great variety of methods—and those enumerated do not begin to exhaust the list—shows that the particular differences between them are of no consequence, but that any device based upon the faith of the patient may be employed to utilize the control which the mind, under certain circumstances, may exercise over the so-called vegetative processes of the human system. That the most powerful suggestion may fail of its object is, of course, perfectly well-known. A case is reported of a German peasant, unpleasantly endowed with too many warts, who stood on his head in a newly made grave. To a superstitious yokel this was an extremely powerful suggestion, but the warts remained.

Any one who is of the opinion that these remedies for warts can not be effective because they are so little countenanced by scientific medical authority, will see the matter in a new light if he will take the trouble to look up the remedies that are recommended by the medical authorities themselves. A standard medical work (Foster's "Reference Handbook of the Medical Sciences") names a few of them and dismisses the rest with the remark that they are too numerous to mention, as every physician has his favorite remedy. The diversity among these remedies being as great as among the popular cures, the inference seems justified that there is nothing inherently curative in the one class any more than

in the other, but that they all depend upon that principle which is common to them all—the principle of suggestion.

The strange, the mysterious and the weird have great suggestive potency, and hence drugs culled at unearthly hours, during unusual conjunctions of the moon and planets, on St. John's or St. Agnes' Eve, have unusual curative properties. The rare stone bezoar, or bezar—a concretion found in the intestines of certain animals like goats—was believed in colonial New England to have magical powers. Any mysterious rite may be efficacious if linked with a vague but strong superstitious belief. In 1884, two children in Suffolk, England, between Needham and Barking, were reported cured of infantile hernia by means of the cleft-ash rite. The procedure was as follows: A sapling was split upward, beginning a few feet from the ground and tied at the top to prevent the cleft from extending all the way up. The cleft was held open and the child passed through three times, head downward, each time by a different person. The sapling was then bound up securely at short intervals. It grew together again—which was supposed to be the reason why the children recovered.

Miracles are sometimes due to the reinforcement of suggestion by the fascinatingly horrible, and hence the curative property of things associated with corpses, skulls, gallows, graveyards and so on. One of the many remedies for ague in England is to wear chips from a gallows around one's neck; for a wen one should go alone at night to the spot where a fresh corpse lies—preferably that of an executed criminal—and pass its hand over the wen. A poor woman living in the neighborhood of Hartlepool, England, some years ago was induced by a "wise woman" to go alone at night to an outhouse where a suicide lay awaiting the coroner's inquest and to hold the hand of the corpse on her wen all night. She died shortly after from mental shock. Another woman at Cuddesden, Oxfordshire, asked for the hand of a corpse in order to cure a goiter. Her father, she said, had been cured by the same means, the swelling having diminished as the hand mouldered away. In 1850, it was common for numbers of invalids in certain parts of England to congregate round the gallows in order to receive the "death stroke"—the touch of an executed criminal's hand. The practise declined because of the high fees the hangmen came to charge for applying the remedy.

There was a time when powdered mummy was a highly valued medicine throughout Europe. Carbonized and powdered animals are still used in China and Japan, as crushed bones once were in England. The celebrated chemist, Robert Boyle, relates, in his essay on "The Porousness of Animal Bodies," how, "having been one summer frequently subject to bleed at the nose and reduced to employ several remedies to check the distemper, that which I found the most effectual to staunch the blood

was some moss off a dead man's skull (sent for a present from Ireland where it is far less rare than in most other countries) though it did but touch my skin till the herb was a little warmed." Mere contact with the gruesome object was sufficient.

Will it be objected that Boyle was deceived and that his nose-bleed could not have been stopped as he says it was? Let it be remembered that the possibility of controlling hemorrhages by suggestion has been demonstrated repeatedly by experiment on subjects under hypnotism. The Emmanuel practitioners have done it by their methods. The Bible reports a case, and the popular devices for stopping nose-bleed are about as numerous as for curing warts—one of the most favorite being to slip a cold key between the skin and the clothes. Boyle tells of another case, that of a young man, whose nose-bleed was stopped by the external application of an agate, and in his collection of household remedies he mentions, among other instances of suggestive therapeutics, the holding of a certain herb in the hand as another excellent measure against nose-bleed.

The horrible was relied upon by the Romans to give them the requisite psychic shock. They drank the blood of gladiators for epilepsy, and to-day in Denmark, China and Switzerland, curative suggestion for epilepsy, hydrophobia and consumption is obtained from the blood of decapitated criminals. The Egyptian kings took baths of blood to cure elephantiasis, and the Vikings drank from the skulls of their conquered foemen at solemn festivals. Next to the horrible, the loathsome and nauseating have been utilized. The bitter medicines that used to be prescribed by the old-fashioned doctors, and the vile compounds made from the excreta of goats, cats, dogs, mice and other animals owed their curative properties to the same principles. Nor have the worst of these medicines passed away from civilized lands, as a little inquiry among some of the latest arrivals from rural Europe has demonstrated.

Belief in the curative power of the means employed is the most important element in its success. We know now that it does not so much matter upon what the belief is based so long as the belief is strongly present. Faith, in former ages, was almost entirely at the command of religious ideas. To-day, faith in scientific conceptions and scientific authority has largely taken the place of religious faith. Let a man feel that a certain mode of procedure rests upon scientific principles, and the method, whether right or wrong, will have therapeutic value. Cures recommended by popular tradition are contemptuously dismissed as mere relics of ancient superstition, but any remedy administered with a show of scientific reasoning and authority is sure to produce results. A slight examination of the scientific remedies for whooping-cough will show how true are these observations.

The number of approved remedies for whooping-cough is about as

large as for warts. Only a few will be mentioned here. Schlief used a bath of compressed air and reported eighty-five per cent. cured in fifteen seances. Gay, supposing that "the sublingual ulcer was the initial specific of whooping-cough, cauterized it with nitrate of silver and reports several cases cured in a short time!" Mohn has reported cases of whooping-cough "cured as if by enchantment" by the use of sulphur fumigators. The child is dressed in clean clothes and sent from the room, which is closed and fumigated with burning sulphur for five hours in the morning. After the room is aired the child sleeps there at night. One trial is generally sufficient for a cure! These observations have been enthusiastically confirmed by Manly.[1] Another physician cured 101 cases out of 169 by letting them inhale illuminating gas. Still another cured 219 out of 341 by the same method. Powdered benzoin cured 75 per cent. of one physician's cases. Seventeen patients were cured by another with boric acid and roasted coffee, and so on *ad infinitum*.[2]

There is, of course, no intention here of disputing the correctness of these statistics. They have been quoted only to show the similarity between the curative principle underlying them and that relied upon by a woman, probably of German descent, who was seen on the bank of the Schuylkill River, holding a live fish head foremost in the mouth of her child in order to relieve the child of the whooping-cough. The principle is plainly brought out again in the injunction to one seeking a remedy for his disease "to follow the directions given by a man riding on a piebald horse."

Religious emotion has undoubtedly been the most powerful agency known for energizing curative suggestion. We usually call it impotent superstition when it appears among lowly or primitive peoples. The Malay is patently and grossly superstitious when he recites: "Not mine are the materials, they are the materials of Kemah-ul-hakim. Not to me belongs this neutralizing charm. It is not I who apply it. It is Malim Karinim who applies it." But if he believes in Kemah-ul-hakim and Malim Karinim and is tremendously impressed by the formula he recites, we need not hesitate to believe that—sometimes—he is cured thereby.

The Englishman of Elizabeth's day was no doubt immensely superior in mental power to the poor Malay who has just been quoted. His religion was more logical and more efficacious than that of the Malay and perhaps his charms worked oftener. To the cold and unfeeling eye of science, however, the therapeutic principle in the charm, spoken by the Malay and that spoken by the Englishman is the same. This was the Elizabethan Englishman's charm for ague:

[1] Mohn in the *Revue Internationale des Science Med.*, November, 1886, and *The Practitioner*, August, 1888.

[2] Quoted in Foster's "Handbook."

When Christ saw the cross, He trembled and shaked and they said to Him, Hast thou the ague? And He said unto them, I have neither ague nor fever; and whosoever bears these words, either in writing or in mind, shall never be troubled with ague or fever. So help thy servants, O Lord, who put their trust in thee.

The same Englishman recited, in order to stop a hemorrhage:

So may it please the Son of God. So His mother Mary. In the name of the Father, stop, O blood! In the name of the Holy Ghost, stop, O blood! In the name of the Holy Trinity.

It is no longer possible, as was only recently the tendency, to deny all the miraculous cures ascribed to sarcred relics and to the touch of saintly persons. Science formerly had no explanation to offer and dismissed all such claims with contempt. They must now be admitted to be at least of possible occurrence. Authentic cures by healers not of the most exalted character have taken place in our own day almost before our very eyes. Faith in the power of a supposedly sacred personality has made them possible. In the hey-dey of royalty the divinity that was believed to hedge a king produced the undisputed cure of many a wretched invalid. Between three and four hundrd persons were said to have been cured by Queen Elizabeth annually of scrofula or the King's Evil. James the Second is reported to have cured three hundred and fifty at one time amid great pomp and ceremony—a circumstance that doubtless contributed materially to the success of the operation.

Religion after having been expelled by science from the field of therapeutics is now being invited back again. Science is obliged to admit that it was mistaken in its wholesale condemnation of appealing to religion in illness. And this change of attitude on the part of science has been brought about by the rise of two or three new concepts—suggestion, subconsciousness, multiple personality. That which formerly seemed absurd, now seems perfectly reasonable. It seems as reasonable that healers of the sick should make use of the immense suggestive reinforcement of religion as of the aid lent by the newer authority of science.

Unenlightened members of the medical profession in their desire to discount the achievements of psychotherapy declare that all that is of value in the new methods has long been known and used by regular practitioners. A large part of this claim is perfectly true. We all know that the success of many a prosperous physician is not due to his superior scientific equipment—in which he often is notoriously lacking—but to the faith inspired by his "personality." In some instances, gentle, soothing tones, in others, brusqueness and peremptoriness of manner, convey the very useful suggestion of great ability justified in its assumption of authority. The particular remedy prescribed after that is of no consequence.

But we must go a step farther. We must admit not only that regular medical practitioners have been making use of the principles of suggestion, but that the people at large, the common people, the ignorant and the superstitious, have had an intuition into their nature and have been practising psychotherapeutics, with more or less of success, from the dawn of history down to our own day. The practise of medicine is, even to-day, an art largely based upon empirical rules learned from the experience of the common people. Scientific medicine has in the past adopted into its pharmacopœia a great many of the "simples" cherished by the people, but has discarded their innumerable hints as to the value of psychotherapy. It is now beginning to turn to this neglected wisdom, to make use of the spiritual "simples," to learn what curative powers reside in the soul.

THE STRUGGLE FOR EQUALITY IN THE UNITED STATES.

IV

By Professor CHARLES F. EMERICK

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The Courts and Public Opinion

I

MANY are disposed to take exception to popular criticism of the courts. This point of view merits consideration because it is entertained by some who are genuinely progressive in spirit as well as by reactionaries. It is the position of those who think the tyranny of the majority is our greatest menace and who look upon the courts as the bulwark not only of property, but of personal liberty. It reflects the traditional respect in which the courts are held.

It is quite generally conceded that there are certain limitations to criticizing the courts which need not be observed in the discussion of other matters. During the trial of a case, remarks which obstruct the administration of justice are clearly out of order. Neither can the expression of views well be justified which counsel resistance to the decrees of the courts after they have once been rendered. So long as the decision of a court stands as the law of the land, it should be obeyed, unless an exception be made where matters of private conscience are involved. But this in no wise precludes bringing a similar case before the court with a view to having the point at issue reargued and the decision reversed, neither does it preclude popular discussion of the grounds upon which an objectionable decision rests. *Starte decisis* is a rule which admits of exceptions. The second legal-tender case is a conspicuous example. The view expressed by the Supreme Court in the Dartmouth College case has been "substantially modified, if not abrogated altogether."[1] Those who object to any and every criticism of court decisions forget that the law is not a hard and fast thing, but is all the time in the making, changing with the prevailing sense of right, and that discussion and criticism by the laity as well as by members of the bench and bar are helpful to this end. When there is great diversity of opinion among members of the bench upon a question, the general public can not well be denied taking part in the discussion, especially when some question of governmental policy is involved in regard to

[1] Christopher G. Tiedeman, "The Unwritten Constitution of the U. S.," p. 66.

which the public is confessedly the final arbiter. Moreover, since judicial interpretation frequently either enlarges or contracts the meaning of statutes and constitutions, the courts can hardly hope to escape without criticism. And where the courts occasionally declare legislative acts unconstitutional, as they do in the United States, popular criticism is almost inevitable. There is as little reason to expect the courts to escape unscathed by the sharp wing of criticism as to expect the soldier on the firing line in time of battle to escape the risks to which he is unavoidably exposed. It is useless to try to taboo the tendency of the popular mind to criticize the judiciary. The only recourse for either party to the controversy is to assume that the other is possessed of a rational nature and to try to contradict error with truth.

In the oft-quoted words of Ex-President Taft:

> The opportunity freely and publicly to criticize judicial action is of vastly more importance to the body politic than the immunity of courts and judges from unjust aspersions and attack. . Nothing tends more to render judges careful in their decisions and anxiously solicitous to do exact justice than the consciousness that every act of theirs is to be submitted to the intelligent scrutiny and candid criticism of their fellow-men. In the case of judges having a life tenure, indeed, their very independence makes the right freely to comment on their decisions of greater importance, because it is the only practicable and available instrument in the hands of a free people to keep such judges alive to the reasonable demands of those they serve.

These observations are especially true in a country where the springs of authority are supposed to reside in and to issue from the people. In a country where the divine right of kings is in vogue, there is a certain consistency in placing popular criticism of the courts under the ban, but such action is incongruous in a country committed to the idea of popular rule. The courts are ordained and established by man to promote the ends of justice, and since the creature can not be greater than its creator it is within the realm of the possible for the people to abridge the power of the courts and to reconstitute them on a different basis. The constitution leaves the establishment of courts inferior to the Supreme Court to the discretion of Congress. The original jurisdiction of the Supreme Court is specifically limited to cases affecting ambassadors, other public ministers and consuls, and cases in which a state is a party, and its appellate jurisdiction is subject to such exceptions and such regulations as Congress shall make. In providing for its own amendment, moreover, the constitution makes no exception of the judicial system for which it provided, but frankly admits that in this as well as in other respects it may become outgrown and require modification. Certain current writers appear to think that the framers of the constitution uttered the last word of wisdom upon the judiciary. The framers themselves did not entertain this delusion. The last Republican platform recognizes that all is not well with the courts, and accordingly favors legislation to the end of preventing "long delays and

the tedious and costly appeals which have so often amounted to a denial of justice in civil cases and to a failure to protect the public at large in criminal cases." Still more significant is the approval of "such action as may be necessary to simplify the process by which any judge who may be found to be derelict in his duty may be removed from office."

II

The current tendency to criticize the courts is nothing new. It has existed ever since the foundation of the government. Jefferson denounced the decision of the Supreme Court in Marbury *v.* Madison. Jackson vetoed a bill renewing the charter of the United States Bank on the ground that it was unconstitutional, although the Supreme Court had pronounced a similar bill constitutional, and Lincoln strongly dissented from the Dred Scott decision. Moreover, in at least three instances the President has gone so far as openly to disregard an order or a decision of the Supreme Court. Jefferson refused to answer to a subpœna issued by Marshall for his appearance as a witness at the trial of Burr. Jackson's celebrated remark, "John Marshall has rendered his decision, now let him enforce it," will probably never be forgotten. Lincoln ignored the opinion of Chief-Justice Taney that the suspension of the writ of habeas corpus by presidential proclamation was unconstitutional. States have also refused to obey the decisions of the court.

Criticism of the courts is especially rife at present and promises to become still more common. First, the readiness with which injunctions are issued at the behests of employers in controversies between capital and labor irritates the working classes. Blanket restraining orders issued now and then without the parties enjoined having a chance to be heard in court and occasional instances in which peaceful persuasion is placed under the ban stir up bad blood and create the impression that the courts are the tools of the employing class. Amendment number twenty-two submitted to the voters of Ohio in 1912 contained the following:

> No order of injunction shall issue in any controversy involving the employment of labor, except to preserve physical property from injury or destruction; and all persons charged in contempt proceedings with the violation of an injunction issued in such controversies shall, upon demand, be granted a trial by jury as in criminal cases.

This amendment failed to carry. Nevertheless, the large vote which it received indicates much dissatisfaction with the manner in which the courts at present issue injunctions and punish for contempt in labor cases. This amendment received 240,896 votes as compared with 257,302 cast against it, though in limiting the injunction to the preservation of physical property it forbade its use to protect the good-will of a business or the lives of the community from intimidation and acts of violence.

In the second place, the courts have become the targets of adverse criticism by declaring social legislation unconstitutional. One has but to recall the popular disapproval aroused in recent years by the decisions of the New York Court of Appeals. Laws that prevented the manufacture of tobacco in tenement-houses, safeguarded life against dangerous machinery, limited the hours of labor of women in factories to ten hours a day for six days in the week, and the Workingmen's Compensation Act have been held unconstitutional. These decisions have done much to provoke the belief that the courts are unsympathetic with humanitarian measures and that they unwarrantedly interfere with legislative discretion.

> The people believe in their courts, they admire and love many of their judges, yet they feel, vaguely, perhaps, but persistently, that something is wrong about a judicial system under which a few men obstruct the will and the needs of the many on matters which seem to involve no question of substantial right at all, so far as individuals are concerned, but only divergences of view as to what is expedient and proper so far as society, as a whole, is concerned.[2]

A third fact, and one often emphasized by Ex-President Taft, concerns the almost interminable delay incidental to judicial procedure in many parts of the United States, the practically endless opportunity for appeal, the frequency with which the outcome of litigation turns upon some technicality of the law and not upon justice, and the fact that the winner in a lawsuit is often the man with the longest purse and not the man with a just cause. The legal profession is prone to procrastinate. Compliance with the forms of law instils the habit of delay. To postpone action until an important witness for the opposing side moves away or dies, or until some other desired event happens, is a favorite device. A banker of long experience tells me that the average business man takes considerably less time to settle an estate than the average lawyer. In the state of New York since 1848, three out of every five cases have been decided upon some point in procedure in place of being decided upon their merits. In other words, the doing of justice has been subordinated to the enforcement of technical rules. The plaintiff in a divorce case failed to secure a decree because the words, "Action for divorce," were written on the back in place of on the face of the summons to her husband, as required by the statutory code. If the action had been to recover a penalty, the "general reference to the statute" should have been placed upon the back of the summons.[3] Failure to do justice, consequently, is sometimes due to the fact that the statutory codes governing procedure leave the courts no discretion. When one considers how much the usefulness of the Interstate Commerce Commission was for years impaired by judicial obstruction, it is

[2] William L. Ransom, "Majority Rule and the Judiciary," p. 36.

[3] George W. Alger, "Swift and Cheap Justice," *The World's Work*, Vol. 27, 1913, pp. 56–57.

apparent how frequently the law's delay in the case of the ordinary man must defeat the ends of justice. So uncertain and expensive is justice secured at the hands of lawyers and courts that many men of affairs settle their controversies by arbitration. The ordinary man, unless of a contentious nature, often finds the cost of justice prohibitory. One result is to encourage aggression by wrongdoers. In trials before Justices of the Peace, the defendant frequently permits judgment to be rendered by default, and a year or two may elapse before the case is tried in a higher court. Needless appeals and retrials may result in the lapse of a much longer time before the case is finally decided. "Litigation for the sake of litigation ought to be discouraged. But this is the only form of petty litigation which survives the discouragements involved in American judicial organization and procedure."[4] Moreover, many members of the legal profession to their discredit are averse to changing a system which inures to their personal advantage. It is little wonder, consequently, that among the well-established planks in the platforms of the Socialist party is the demand for free justice. To the end of remedying the existing condition the people of Ohio, in 1912, provided for one trial and one review by amending the state constitution.

In the fourth place, the courts are not organized on a business basis. The records which disclose the comparative amounts of work done by the different members of the bench are usually sadly deficient. The Municipal Court of Chicago "is the only court, as yet, which is so organized as to be able to furnish adequate statistics of judicial administration."[5] There is too much piecemeal dealing with cases by judges whose jurisdictions overlap. As many as twenty-two different justices have heard different proceedings in a single cause.[6] There is a lack of supervising officers whose duty it should be to place the several members of the bench where they can do the most effective work. The judges in the circuit and superior courts of Chicago "draw lots to see who shall hear chancery cases. There is no possibility of specialization. They do their work in the criminal court for a year at a time in rotation." The Courts of Common Pleas in Philadelphia "are split up into five air-tight compartments, each an absolutely distinct court," with no possibility of transferring cases from one court to the other. In some courts the time of lawyers and litigants is needlessly wasted by calling cases from day to day that are too far down the list to stand any chance of trial.[7] Another mistake lies in depending upon incompetent tribunals to dispense justice in petty cases, such as those presided over by the ordinary Justice of the Peace. Individual judges of the same court

[4] Professor Roscoe Pound, "The Administration of Justice in the Modern City," *Harvard Law Review*, Vol. 26, 1913, p. 320.

[5] *Ibid.*, p. 315.

[6] *Ibid.*, p. 314.

[7] George W. Alger, *op. cit.*, Vol. 26, 1913, pp. 658, 662 and 663.

occasionally block each other. In the history of the Erie Railway, the interference of some of the Supreme Court judges of New York with each other assumed scandalous proportions. The contending parties instituted proceedings before competing judges friendly to their respective interests.[8] The popular impression that the courts are organized to give business to lawyers and to afford jobs to place-hunters rather than to promote the ends of justice is by no means groundless. The cost of our judicial system to litigants plus the excessive cost saddled upon the taxpayers will sooner or later attract the scrutiny of the public. Social legislation that calls for increased expenditures and upon which men have set their hearts will compel economy in our judicial expenditures.

Recent events, however, afford ground for hope. The efficient organization of the Chicago Municipal Court shows what can be done. Municipal Courts are gradually taking the place of those over which Justices of the Peace preside in other cities. The Police Magistrate's Court in New York City has been reorganized in two divisions each of which has a directing head. The dominant note of the reports and proceedings of The American Bar Association manifests less pride in the courts and is more given to criticizing the law and its administration. The courts are suffering the consequences of too much veneration. They need the stimulating effect of a more critical public opinion. "The law needs perennially an infusion of ideas from outside professional circles."[9]

In the fifth place, the seat of authority is gradually shifting toward the popular mind. This is a fact of fundamental importance and is one with which it is as useless to quarrel as with the tides. Socialism and trade-unionism are redistributing the center of authority. Our educational system, the railroad, the steamship, the telephone and telegraph, the postal system, the newspaper and cheap magazine, in short, all the facilities which quicken the popular intelligence, are opposed to making a fetish of the constitution and of the courts. Judicial infallibility as well as infallibility in the matter of religion is out of keeping with the spirit of the times. It is too late to return to the theory of dependence according to which

> the lot of the poor, in all things which affect them collectively, should be regulated *for* them, not *by* them. . . . The poor have come out of leading-strings, and can not any longer be governed or treated like children.[10]

Sixth, the demands made upon the courts are becoming more exacting. A keener conception of justice is spreading throughout society. Busi-

[8] Charles F. Adams, Jr., and Henry Adams, "Chapters of Erie and other Essays," pp. 1–99 passim. Pages 18–24 are especially illuminating.

[9] Professor Roscoe Pound, *op. cit.*, p. 319.

[10] John Stuart Mill, "Principles of Political Economy," edited by W. J. Ashley, pp. 753 and 757.

ness conduct once in perfectly good standing is being called in question. Are sweatshop conditions just and right? is a question asked on every hand. The American people are waking up to the fact that an abundance of free land rather than the excellence of their institutions has been the secret of much of the success which they have achieved, and that the disappearance of the former renders reliance upon a happy-go-lucky system of dispensing justice no longer prudent. Moreover, justice has ceased to dwell among the clouds and a larger measure of it is within the grasp of the ordinary man if he but asks for it. People are demanding justice here and now and can no longer be put off with promises of bliss in the hereafter.

Modern civilization is imposing heavier burdens upon the courts in still another way. The growing complexity of the environment has greatly increased the sum total of human relations and changed the character of many old ones. The relations between employer and employee when the two worked side by side bore little resemblance to what they are to-day in connection with a trunk-line railway or gigantic trust. The staple necessaries of life which every community once produced for itself are now supplied through the portals of the world market. Producer and consumer have ceased to be neighbors and the personal relations which once obtained between them have ceased to exist. The problem of regulating the relations which exist between the public on the one hand and the railways, trusts and labor organizations on the other baffles the keenest minds.

Again, we have become less exultant as a people, less confident of our future, less disposed to leave our destiny as a nation to drift without a guiding hand and purpose. There is a growing sense that a

> better future, just in so far as it is better, will have to be planned and constructed rather than fulfilled of its own momentum. . . . The way to realize a purpose is, not to leave it to chance, but to keep it loyally in mind, and adopt means proper to the importance and the difficulty of the task.[11]

The suspicion is growing that the self-interest of the individual is not at one with the public welfare. There is misgiving lest barriers arise to obstruct the process whereby men of ability, no matter how humbly born, have hitherto risen to positions of trust and leadership in the community. There is fear lest a system of caste get such a foothold that young men of promise will cease to aspire and rest content with the stations in life in which they happen to be born. There is a keener sense of social responsibility and less of a disposition to hold the individual responsible for human failure. Poverty is not regarded as a condition to which large numbers of men are hopelessly condemned. In short, an atmosphere of seriousness has swept over the nation and imposed more difficult tasks upon the courts.

[11] Herbert Croly, "The Promise of American Life," pp. 6 and 24.

A democratic ideal makes the social problem inevitable and its attempted solution indispensable.[12]

Seventhly, the popular suspicion that judicial decisions unduly favor the interests of corporate wealth is apparently increasing. The reasons are not far to seek. The road to a judgeship often lies through an attorneyship for some great corporation, and an unconscious if not a conscious bias is believed to follow a man when he ascends the bench. Association with the comfortable and well-to-do is thought to exert a similar influence. The indiscretion of certain prominent jurists in accepting Pullman and other railway passes, and in going on junkets as the guests of railway attorneys whose clients either have or some day may have cases in court naturally arouses suspicion. Active participation in politics by members of the bench, nepotism in the appointment of railway receivers and the distribution of other choice plums, the auctioning off of judicial nominations to the highest bidder, promotions to judgeships as a reward for services rendered political machines closely allied with corporate interests,—these and other infractions of the law of fair play have lessened the prestige of the courts. Fortunately, however, instances of corruption on the bench are still believed to be the exception and not the rule.

In the eighth place, the most common criticism of the courts does not concern their integrity, but "the comparative inflexibility of the judicial mind, a certain blindness to the changing social and economic order, an exaggerated veneration for ancient principles of law, established under conditions which no longer apply."[13] Tradition and precedent are all well enough as guides in a stationary environment, but they lose much of their utility amid shifting conditions. It is worthy of note that some of the courts are less frequently the target of adverse criticism than others, and the Supreme Court probably least of all. More or less florid rhetoric is occasionally employed in denouncing the decisions of that body, but I do not recall any decision within a lifetime against which the taint of dishonor has been brought by any one entitled to belief. Moreover, partly because long years of service on the bench make for a public rather than a private point of view, and partly because climatic, geographical and economic conditions in the United States are more diverse than in any one state, the decisions of the Supreme Court are relatively flexible.[14]

The legal precedents which have arisen amid rural conditions may prove a misfit in a large city. The reasons are apparent. The rural mind inclines to a minimum of public control. It is jealous of authority. It emphasizes the rights of the individual rather than the social interest. It explains the presence of Bills of Rights in the con-

[12] *Ibid.*, p. 25.

[13] Walter E. Weyl, *op. cit.*, p. 112.

[14] Frank J. Goodnow, "Social Reform and the Constitution," pp. 330–331.

stitutions of the several states. It also accounts for our system of checks and balances. A modern urban community, if left to itself, would hardly shackle its power to act by such devices. The Kentucky mountaineer who carries his individualism to the point of taking the law into his own hands in place of relying upon the regularly constituted authorities is the forerunner of the present rural point of view. Moreover, the farmer is less familiar with social and economic changes than people who live in cities. Agriculture is less subject to revolutionary changes in machine production than manufactures. Tradition is more potent in the country than in the city. The opportunity for keeping public opinion abreast of the times by publicity and discussion is better where population is dense than where it is sparse. The vote on the forty-two amendments to the constitution of Ohio submitted to the voters in 1912 illustrates the condition of the rural mind. Of the thirty-four amendments adopted, all, save woman suffrage, carried in the twelve leading urban counties of the state. Nineteen of these amendments would have been defeated without the vote of the urban counties. Seven amendments were defeatd "in spite of the favorable majorities cast by the cities."[14a] The urban counties contain less than half the population of the state. Nevertheless, "every amendment that passed received its heaviest majority in the cities."[14b]

The average farmer can have little conception of the problems which confront the modern city. Rural constituencies are proverbially conservative on questions outside of their experience. In a law-abiding country community, a suit for damages may prove an adequate remedy for occasional infractions of the law, but in an urban environment far more latitude should be given administrative officers, such as factory, tenement-house and meat inspectors, to prevent anti-social practices. The modern city is mainly a development of the last fifty years. It is not surprising, therefore, that the judicial mind steeped mainly in the old traditions of the law sometimes fails to do justice. The Court of Appeals in New York has usually been made up almost entirely of what are called "up-state" judges. The Supreme Court of Illinois consists of seven judges elected from as many districts. The seventh district includes the city of Chicago and comprises 46.4 per cent. of the population of the state. Courts constituted in this way may easily blunder in deciding cases that affect the metropolis.

Professor Roscoe Pound, of the Harvard Law School, says:

> Almost all of the backwardness of American courts with respect to social problems and social legislation has been backwardness with respect to social problems of our cities and social legislation for our cities. Is it not obvious what a difference it would have made if the every-day social relations of the judges of our highest courts had been in New York instead of Albany, Chicago

[14a] Robert E. Cushman, "Voting Organic Law," *Political Science Quarterly*, Vol. 28, 1913, p. 222.

[14b] *Ibid.*, p. 220.

instead of Springfield, St. Louis instead of Jefferson City, and so on? Is it likely that a court sitting in New York City would have gone wrong in construing tenement-house legislation? Questions may well seem abstract and academic in Albany or Springfield that are concrete and practical in New York or Chicago. Judges there may well fail to appreciate the practical aspects of legislation which a court sitting in the metropolis, whose judges met and talked with social workers in the ordinary intercourse of society, would perceive. Our rural capitals are not a little to be blamed if the course of justice in our highest court with respect to urban problems has been guided largely by judges who looked at them through rural spectacles.[15]

Finally, the difficulty of amending the constitution of certain states, and especially the federal constitution, is bringing the judiciary into disfavor. When the nation consisted of a homogeneous population confined to the Atlantic states, the amendment of the constitution offered no insuperable difficulty. The framers of the constitution could not have intended to provide the country with an inflexible instrument, for "they were trying to escape from the restraints of a still more rigid constitution."[16] None the less, with the growth of slavery, the admission of new states, the development of manufacturing, mining and commerce, and the consequent emergence of sectional differences, the difficulty of amendment has increased until vetoes interposed by the courts have become less and less suspensory and more and more absolute in character. Nearly eighteen years were required to restore to Congress the power to levy an income tax, though it was generally supposed that Congress possessed this power until the adverse decision of the Supreme Court in 1895. As a matter of fact, Congress imposed an income tax in 1861 and the Supreme Court held it constitutional.[17] For more than two generations there was an increasing demand for the election of United States senators by popular vote, but so difficult did formally amending the constitution prove in this case that years before it was accomplished election by the legislature became a mere form and was superseded by direct primaries in many states. No other important country is operating under such a rigid constitution. Amendment by interpretation is occasionally practised by the courts, but too infrequently to afford an adequate remedy. Besides, as with religious creeds, forced construction sometimes makes a laughing-stock both of the constitution and the courts. The result is that the American people are barred from passing measures which many other countries deem necessary to their well-being. Among such measures are "pensions or public insurance in case of old age, accident or sickness where the recipient of the pension or insurance is not actually a pauper and where the fund from which such pension or insurance is obtained is derived from taxation; the regulation of the hours of adult male labor in any but the

[15] *Op. cit.*, pp. 325–326.

[16] Professor Monroe Smith, *North American Review*, Vol. 194, 1911, p. 658.

[17] Israel Ward Andrews, "Manual of the Constitution," revised in 1892, p. 83.

evidently most dangerous trades; effective regulation of the use of urban land; and the use of the powers of taxation and eminent domain for the purpose of furthering schemes to provide aid for the needy classes."[18]

III

Current discussion during the last presidential campaign centered a good deal about the recall of judges and "the recall of judicial decisions." Many high-minded and conscientious men strenuously object to both of these proposals. But whether they mark so radical a departure from the present order as to be wholly out of the question is more than doubtful. Every advance in popular government has excited the fears of many God-fearing men. The abolishment of the property and religious qualifications for the suffrage meant to many the speedy downfall of our institutions. An electoral college merely registering the will of the people seemed the height of folly to most of the fathers. But a short time ago, the limitation of the veto power of the lords in England seemed impracticable. These facts suggest that the recall of judges and "the recall of judicial decisions" are matters which a rational being may at least dispassionately consider.

The recall of judges by legislative address already exists in several of the states, but it is rarely exercised. Moreover, in the states where the judges are elected and are subject to reelection at the end of their term of office, one would expect to find numerous and glaring examples of the evils like those which the judicial recall is supposed to invite, and yet I am not aware of a popular movement in any one of these states which looks towards electing judges for life or substituting an appointive for an elective judiciary.[19] On the contrary, in some of these very states there is a formidable movement for the judicial recall. It is true that the public has now and then foolishly dispensed with the services of an eminent jurist for one that is grossly incompetent. The loss of Judge Cooley to the Supreme Court of Michigan is a conspicuous instance. But then again, Judge Gary who presided at the trial of the Chicago anarchists was repeatedly reelected. The disadvantages which attend an elective judiciary are apparently more than offset in the popular mind by the advantages. The actual working of the judicial recall would manifestly depend very largely upon the safeguards thrown around its operation. After all, the stronghold of the judiciary does not lie in its technical independence, but in the traditional respect in which it is held. So great is this respect that it is probable the recall would rarely be applied to judges save on the ground of malfeasance in office. Probably no state can boast of a more independent and upright judiciary than Massachusetts, where judges can be removed by the governor and

[18] Goodnow, *op. cit.*, p. 332.

[19] In 1905, judges were elected by popular vote in thirty-three states. See Goodnow, *op. cit.*, p. 340.

council without a hearing and without assigning the ground for removal upon the address of a bare majority of the legislature.[20]

The issue is not between those who want a judiciary that is subject to the passing whims of the hour and those who do not. Every right-minded man wants a fearless and upright judiciary, and the only question is how to secure one that is not at the same time the slave of precedent. Mr. Roosevelt's remedy for this state of mind is "the recall of judicial decisions," limited, however, to the recall of decisions rendered by state courts. This would require amending the constitutions of the several states so that a legislative act involving the exercise of the police power, if held unconstitutional by the supreme court of a state, could be submitted to the people and the decision of the court either upheld or reversed. Or the right of recall might be limited to instances where an act is held unconstitutional by a state court on the ground that it deprives one of life, liberty and property without due process of law in contravention of the state constitution. If the decision of the court were reversed, the legislative act would thereafter be excepted from the constitutional prohibition. "This," Judge Grosscup points out, "would be amendment and not construction, the exercise of legislative and not of judicial functions by the people."[21] Strictly speaking, therefore, the proposal is not a recall of judicial decisions at all, but a plan for amending the constitutions of the several states. In other words, a decision handed down in any particular case prior to the time "the recall" or amendment took effect would be *res adjudicata,* but in similar cases arising thereafter the state courts would be obliged to uphold the constitutionality of the statute. The state constitutions as amended in accordance with this plan would be subject to all of the guaranties of the federal constitution just as they are at present.

It is difficult to see why any one should be either wildly enthusiastic or vindictively opposed to such a plan. It involves no new principle. It assumes that the sovereign power rests in the people and that constitutions rightly emanate from and embody the deliberate will of the majority, assumptions that are fundamental to the American constitutional system. There is no more reason why it would result in hasty and ill-considered changes in the constitutions of the several states, or why it would enable a majority to ride rough-shod over the rights of a minority, than is possible under the method of amendment now in vogue. It preserves the tradition in accordance with which the courts declare legislative acts unconstitutional. It would permit the decision of a court to be reversed only in the sense that the eleventh and sixteenth amendments to the constitution reversed the decisions of the Supreme Court. A mode of amending the state constitutions that meets with the approval of a jurist of such well-known conservative tendencies as ex-

[20] William L. Ransom, *op. cit.*, pp. 85–86.

[21] Charles H. Hamill, "Constitutional Chaos," *The Forum*, July, 1912, p. 50.

Judge Grosscup can hardly be ultra-radical. As compared with the "constitutional initiative" which exists in California, where an amendment may be initiated by the people without prior formulation by the legislature, Mr. Roosevelt's proposal is conservatism itself.

Moreover, it is conservative in another respect. It is customary at present to abrogate completely the "due process" clause of a state constitution in such states as New York, so far as legislation to safeguard the lives, health or safety of employees is concerned, to enable the legislature to pass a workingmen's compensation law that will stand fire in the courts. That is, the state constitution is amended so as to give the legislature *carte blanche* in enacting such a law. Beyond doubt, a plan of amendment which enables a particular statute to be validated and leaves the "due process" clause of the state constitution stand against radically different legislation upon the same subject is the more cautious going. A discriminating advocate of the "recall of judicial decisions" aptly says:

> We do not wish to take down *all* constitutional restrictions on an entire class or category of legislation, good or bad, merely to take one sound, wise law out from under the ban. The people do not seek a safety-valve like the whistle on the Mississippi River steamboat described by Lincoln, which stopped the boat whenever the whistle was blown, nor do they want the safety valve of orderly progress in legislation "*tied down*" beyond the power of the people to utilize when needed. A method of dealing only with the specific statute when the need arises, rather than framing broad generalizations to take all similar statutes out of the prohibition pronounced by the court, has much to commend it to the conservative common-sense of our citizens. . . . Is it not better that the people should pass . . . upon the public necessity and social justice of a *particular law* which some court may reject, than that, in advance and for all time, broad and paralyzing terms of general exemption should be written into our historic guaranties? Why break out a window, instead of merely raising it, for ventilation?[22]

"The recall of judicial decisions" has been rejected by many on the ground that it is too radical. So far as I am aware, Colorado is the only state thus far to adopt it.[22a] In the long run, it may be rejected because it is not radical enough. Many have erroneously supposed that it contemplates submitting to popular vote the issues in a case that has already been tried in court, whereas it merely provides a method for determining the rules that shall govern the trial of similar cases in the future. If adopted, the courts could declare unconstitutional every material increase in a piece of social legislation and necessitate a referendum. In no event, could the people of a state do more than bring the interpretation of the "due process" clause of their fundamental law abreast of the views of the Supreme Court, and they could not do even this if the highest court of a state held a legislative act contrary to the

[22] William L. Ransom, *op. cit.*, pp. xv–xvi.

[22a] A. Lawrence Lowell, Public Opinion and Popular Government, Appendix B, p. 374.

same clause in the federal constitution. For the federal judiciary act makes no provision for the review by the Supreme Court of such an adverse decision, and it therefore stands as the supreme law of a state beyond the power of its people to recall. If the New York Court of Appeals, for example, held an act contrary to the "due process" clause of the state constitution, the people of the state could reverse the decision, but if the same court held the act contrary to the same clause in the federal constitution the decision could not be "recalled" by the people.[23]

The recall of judges and "the recall of judicial decisions" are not so absurd as to be impossible. Three states have already adopted the former, and the failure of public opinion thus far to take up with the latter may be due partly to the novelty of the proposition and the fact that it became the football of heated controversy during the last presidential campaign. The extraordinary power of the courts to declare legislative acts unconstitutional should not be forgotten. When so level-headed an organ as *The Survey* says that the decisions of the New York Court of Appeals overthrowing the workingmen's compensation and two other acts "should be held up to the reprobation and scorn which they deserve,"[24] surely it is time for every one to give heed. If members of the bar opposed to "the recall of decisions" are wise, they will not content themselves with resolutions of condemnation. They will propose other remedies that are more appropriate. They will try to lessen the abuses which attend the issue of injunctions, and to expedite the trial of cases. They will do everything possible to free the bench from corporate and other sinister influences and to elevate its character. They will use their influence to amend the Judiciary Act so that state laws held contrary to the constitution by the highest courts of the several states may be reviewed by the Supreme Court. They will strive to have the courts try as hard to find laws constitutional as they sometimes appear to try to hold them invalid. They will endeavor to make it more easy to amend the constitution and the constitutions of such states as Pennsylvania and Illinois. They will duly consider requiring more than a mere majority of a court to declare a law unconstitutional. If a legislative act should be presumed constitutional until the contrary is proved beyond a reasonable doubt, something approaching unanimity among the members of a court may well be required to declare it unconstitutional. It is noteworthy that the people of Ohio in amending their constitution in 1912 adopted a provision to this effect. Amendment number nineteen includes the following:

> No law shall be held unconstitutional and void by the supreme court without the concurrence of at least all but one of the judges, except in affirmance of a judgment of the court of appeals declaring a law unconstitutional and void.

[23] W. F. Dodd, *Political Science Quarterly*, Vol. 23, 1913, pp. 7–10.

[24] Vol. 27, 1912, p. 1895.

IV

In interpreting the "specific clauses" of our organic law, the courts experience comparatively little difficulty, but in interpreting the "general clauses" there is a fair chance that they may go astray. The constitutional prohibition that no state shall grant letters of marque and reprisal, coin money, etc., is not easily misunderstood, but the words of the fourteenth amendment which prohibit the states from depriving any one of property without "due process of law" has a good deal of flexibility of meaning. In a general way, it means that no one shall be deprived of property without a hearing or without compensation unless "the general interests of the community" demand it. The interpretation of such a clause necessarily involves the exercise of legislative discretion.

> Under the constitutional system as developed in this country the political philosophy of the judges is a matter of vital importance. They are policy determining officers, because they have power to declare null and void "on principles of constitutional law which are scarcely more than general moral precepts," laws enacted by the legislative authority. It is this function of declaring laws unconstitutional, especially as violative of broad and undefinable guaranties that "no one shall be deprived of life, liberty or property without due process of law," which has made the courts in this country essentially law making bodies, determining in the end what legislative policies shall or shall not be adopted. . . . There are under this clause no fixed or definite standards for determining what laws are constitutional and what are unconstitutional. Judges are thus exercising political functions, without corresponding political responsibility; and inasmuch as such functions are being exercised in a manner opposed to public sentiment, popular criticism of the courts is a necessary consequence.[25]

What is necessary to the public health, safety and morals is a question which should be determined in the light of the particular facts and circumstances existing at a given time and place. These are matters which "the prevailing morality or the strong and preponderant opinion" of society should properly control.

> A tenement-house act might seem absurd in Arizona, a statute regulating the grazing of sheep might seem absurd in Greater New York. . . . A law regulating the hours of labor in canneries would have been laughed out of the legislature or the courts seventy years ago, for the housewife did her own canning in the wholesome conditions of her own kitchen; yet such a statute may be very necessary under the conditions now obtaining, for example, in the fruit-growing regions of central New York.[26]

A *laissez-faire* philosophy may have answered the needs of our grandparents, but it has little place amid the conditions of modern life. The political philosophy which holds that "that country is governed best which is governed least" may have been all well enough on the frontier, but it is out of date in an age of cities. When man's relations with his fellows were few and far between, comparatively few restraints upon the individual answered every purpose, but in the crowded center and in a time when the railway, the telephone and the telegraph have vastly

[25] W. F. Dodd, *op. cit.*, pp. 3–4 [26] William L. Ransom, *op. cit.*, p. 135.

multiplied social relations a new social creed is demanded. A social philosophy that originated in the age of homespun does not fit the needs of a factory age.

There is no reason why the legal precedents adapted to conserving the welfare of society amid the simple conditions of the past should determine what is permissible amid the complex conditions of to-day.

> We can not regulate modern gas and electrical corporations by decisions rendered in the days of the tallow dip; we can not adequately control four-track steam railroads merely by the law of the stage-coach and the public inn; we can not be content to have our labor legislation forever checked and thwarted by the decisions of a few men out of the many, and those few, not men of to-day, accountable in any way to their fellows, but dead men, who lived in the days when manufacture was carried on only in wholesome towns and villages, on a small scale and without modern "division of labor"—in fact, when few persons even *cared* whether women worked long hours, or little children toiled in mines, or workers breathed deadly fumes as they worked. . . . Of course, if we try to find in 1770 precedents to sustain 1912 legislation as to "sweat-shops" or "underground bakeries" we shall not find any, for there were no "sweat-shops" or "underground bakeries" then, and no one would have cared or tried to pass laws about them then if there were.[27]

To require the courts to decide questions of legislative policy necessarily exposes them to attack, and few things would contribute more to maintain their hold on the good-will of the public than to relieve them from this responsibility. Either a more complete separation of legislative and judicial functions is necessary, or the courts should be kept better informed concerning the seasoned opinion of the community. The opponents of "the recall of judicial decisions" should consequently welcome any and every educational process that helps to keep the courts informed and thoroughly in sympathy with the progressive thought of the age. Well-intended criticism should not be frowned upon, but encouraged. Along with everything else that is human, the courts are likely to err, and criticism is the great corrective of judicial as well as of other error. There is no good and sufficient reason why substantially the same law should be held consistent with "the due process" clause of the constitution of one state and inconsistent with the same clause in the constitution of another state, especially when the law is more urgently needed in the latter and when the Supreme Court upholds its constitutionality. The unqualified manner in which a large portion of the press denounced the clause on the judiciary in the democratic platform of 1896 was most unfortunate. The worst enemies of the courts are those unqualifiedly opposed to calling them to account. Such an attitude suggests that our judicial system will not stand the light of criticism, tends to bring it under suspicion and to undermine its authority. To dam up the free expression of grievances real or imaginary forces people to nurse their wrongs, prevents the orderly correction of injustice, and creates the conditions of a social conflagration.

[27] William L. Ransom, *op. cit.*, pp. 132–133.

THE QUESTION OF AGRICULTURAL POPULATION

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IN current discussions of country life there seems to be the implication if not the direct claim that the urban population of the nation is relatively too large as compared with country population. Regret is general because boys and girls leave the farm. The steady regression of percentage of rural as compared with urban population in the decades of our national life gives rise to apprehension. It is held as a disquieting fact that so many agricultural counties—230 by the last census—should show an absolute decline in population, while the growth of cities is phenomenal.

There are no doubt many reasons for the sentiment in favor of a larger agricultural population. We have not yet come to believe in the city as a normal mode of life. When the older people of the United States were young the country took precedence over the city, and the experiences of childhood passed on the farm perhaps affect the point of view at present. The sentimental claims of agricultural life no doubt color our economics. The sentiment, too, for a return to nature, recrudescing periodically with Horace, Rousseau, Emerson, Thoreau, and John Burroughs, and always deep in the nature of man, fallaciously carries with it the inference that the agricultural population should be relatively large. Of course, the desire for living close to nature has no connection with the economic question of how large the actual agricultural population should be.

But among the most active causes of interest in agricultural population is the high retail price of food. The products of the farm reach the consumer at high expense. It matters little to the consumer where the increase of cost attaches, so long as he must pay prices which by comparison with those formerly prevailing seem to be those of famine. There is perhaps a lurking feeling that farm products should not cost much. The time was when to help oneself to fruit from the farmer's trees or invade his vegetable garden bore not the slightest resemblance to larceny—it simply showed a confidence in the philanthropic nature of farming. Things were "free" in the country, though no one, of course, would feel free to carry off a peck of lead pencils from a stationer's or half a bushel of rubber balls from a toy store.

Let us admit the acceptability of cheaper food. How does this affect the question of agricultural population? Does it follow that

because food is expensive there should be more farmers? It is found that lima beans retailing in New York City for $4.80 a bushel paid the Long Island farmer who grew them 30 cents a bushel, after making allowance for commission and freight charges. Surely the additional charges on food due to the middleman is no justification for more men to engage in agriculture. Food is still cheap as it leaves the hands of the farmer.

Let us also admit the prevalence of unscientific and wasteful methods of agriculture. There is certainly great need of reforming the practise of farming. The abuses of agriculture are so patent, such as the keeping of inferior stock, the neglect of farm machinery in the west, the impoverishment of the soil due to lack of proper rotation of crops and fertilizing, and improper methods of tillage, that public interest has been aroused. But this aspect of agriculture surely does not warrant the cry of back to the land, but rather a demand for more intelligence in production. Indeed, with more scientific farming fewer men would be needed on the land. The increased use of machinery on the farm has already decimated the rural population. It by no means follows from the high cost of farm products at retail or from the evident waste from poor agricultural methods that a relative increase in agricultural population is desirable.

The need of clearness in regard to the real basis for the size of agricultural as compared with urban population is evident. There must be some rather definite relationship between country and city populations, lying deeper than passing modes of thought or superficial enthusiasms. Is there not a question as to whether there should be a relatively larger agricultural population? May it not even be disastrous eventually for migration countrywards to be stimulated? That there are acute questions in regard to the farm and life in country must be admitted. But the very common assumption that there should be a movement back to the farm, in the sense of numbers, may be open to doubt.

May we not first of all dismiss the idea that people leave the farm primarily because of preference for city life? As a matter of fact the country makes an immense appeal to millions of people who are forced to live in cities to earn a living. The hardships of the farm, such as are not forms of poverty, would hardly deter people from living on farms. Hardships did not prevent the "forty-niners" from seeking gold, nor do hardships of weather, exposure, or isolation successfully oppose the seeking of wealth in any field.

It may perhaps be safely argued that the number of persons engaged in any occupation bears a very close relation to the economic attractions offered. If the ease of securing gainful employment is greater in city than in country nothing will prevent a transfer of population. If a farmer with a capital of $4,000 can by moving to town get as much for

his labor as a drayman as he formerly got for his labor and capital, he is likely to move to town and put his money at interest, thus increasing his annual income. A young man in the country after gaining an amount of schooling is ready to offer his services for sale. Where is the best market? In the majority of cases he finds that it is in the city. He follows the job.

The steady and rapid drift of agricultural population to cities implies the economic dominance of the occupations of cities. If the population of cities tends to outstrip that of the country, it is evident that wealth is relatively increasing rapidly in cities. Where wealth is there will men gather. No amount of exhortation or solicitation will avail to turn the tide countryward if the wealth pull is toward the city.

But is the economic dominance of the city and the suction of life out of the agricultural areas normal and legitimate or unnatural and sinister? Should we make up our minds to the steady continuance of the cityward movement or set our faces against it? What is the rationale of the matter?

In this connection perhaps the truest light comes from noting a somewhat overlooked fact in regard to modern tendencies in consumption. The things we buy are increasingly those of the city rather than of the farm. A smaller and smaller percentage of income is being spent for forms of goods associated with the farm. As standards of living improve there arises an ever-increasing demand for things the farm has little or nothing to do with, such as professional services, classes of manufactured articles, and recreations.

Suppose, for example, that a family with an income of $2,000 suddenly acquired a $4,000 income. Would the farm receive a larger sum, provided the whole income were spent on living? Would this family buy more eggs, potatoes or apples? Possibly a little more. But would not practically all of the increase of income go for the goods of the city? Suppose a man inherited a million dollars and set out to spend it. How much more would he spend in which the farmer would directly share? Even in hypothetical expenditures for rare wines and fifty-cent cigars the grape grower and the tobacco raiser would share but faintly, for manufacturing and distributing processes would absorb the lion's share of the retail price. And as for automobiles, grand pianos, works of art, travel and operations for appendicitis, city occupations would be the almost exclusive beneficiaries.

With increase of purchasing power the prosperous consumer wants but little if any more of direct farm products, while his desires for other values soar. Agricultural products cater to a low range of fixed wants, while non-agricultural goods satisfy wants which are ever in advance of power to purchase and are virtually without limit. The wants satisfied by agricultural products may be thought of as occupying the space between parallel lines, while the wants satisfied by non-agri-

cultural goods, the product of cities, occupy the space between the indefinitely extended sides of an acute angle.

Hence it is that the future belongs to the non-agricultural sphere, for we may assume an indefinitely rising standard of living among all classes. Non-agricultural goods and occupations are bound to increase their lead over straight agriculture commensurately with advancing civilization, which implies the acquirement of more wants of acceptable type. Were man but to feed and sleep the case were different. Inasmuch as population, urban and rural, must be correlated with the production of goods and corresponding income there is reason for believing that the drift toward the occupations at present largely local to cities must be accepted as a final decree of civilization.

It is true, of course, that the farm is the source of many materials which enter into manufactured articles. But where manufacturing processes are superimposed on agricultural production, the selling price of the final product is rarely divided at all equally between the farm and the factory. A farmer sells a hide for about the sum received by the department store for a purse. Whole wheat breakfast foods return the farmer one cent to 11½ cents for other industries. The wool in a suit of clothes returns the grower $1.84, while the finished suit is sold by the tailor for $50. Wherever finishing processes are applied to raw farm products, whether in the case of Saratoga chips or peanut candy, the division of the final selling price is usually overwhelmingly in favor of the non-agricultural industries.

Unquestionably in many cases the division is unfair. The farmer does not get enough and other participators get too much. Considering the unflagging labor for long hours on the farm and the almost desperate struggle waged on many a farm for income, it is beyond doubt that the exploitation of the farmer has been equaled by nothing except the factory system at its worst or the institution of slavery. When one considers that a real cabbage must be sold by the farmer for cents while an artificial rose will sell for dollars the irony of the farmer's position is manifest. A steer sold by the farmer for $80 is served in fashionable restaurants for $2,500. The current division of values between farm and city industries is one of the monstrosities of civilization, the correction of which would steady the flow of population to cities, perhaps even suddenly check it for a period, but in view of the nature of human wants the ultimate dominance of city occupations can not be gainsaid.

Assuming a tendency toward correlation between agricultural and urban wealth and population, it is interesting to note the relative standing of city and country at the present time. Is the national population divided between country and city in proportion to the division of wealth?

While the last census gives the rural population as 53.7 per cent. of

the national population, the actual number of residents on farms is much less. In the rural population as reported by the census of 1910 is included the population of towns and villages having less than 2,500 inhabitants. The actual agricultural population is about one third of the national population. In 1910 35.3 per cent. of all persons reported as having gainful occupations were engaged in agriculture.

With one third of the national population engaged in agriculture, we have only to compare agricultural with other production to reach certain inevitable conclusions. Were a parity of wealth distribution maintained between city and county, evidently the income to agriculture should be about equal to one third of the total social production. But is this the case, and if not what deductions may be drawn?

The census of 1910 gives the total value of manufactured articles for the United States for the year 1909 as (in round numbers) 21 billion dollars. The total agricultural production for the same year was 8½ billion dollars. So far the division of social income seems to correspond fairly equitably with division of population. But there is more to be said. When the 21 billion dollars' worth of manufactured articles reaches the consumer the value has been augmented by transportation, advertising and sellers' charges by at least 50 per cent. above factory prices. Probably this estimate is absurdly low. But at the lowest estimate the 21 billion dollars has become 30½ billion, as against the 8½ billion of agricultural production. But wait, the 8½ billion dollars' worth of agricultural products, on its way to the consumer, doubles in value, according to results of investigations of the United States Department of Agriculture. This means that while the farm receives 8½ billion dollars the city occupations based upon agriculture obtain another 8½ billion dollars. Adding this sum to the income of city occupations heretofore given and we have a grand total of 39 billion dollars income for the city as against 8½ billion for the farm. The addition of professional incomes, local to the city, would increase the total by a very large amount. But at the lowest figures the city's share in the division of productional values is 82 per cent. to but 18 per cent. for the farm. Were population apportioned between agriculture and the city on this basis there should be over 75 million people in cities and less than 17 millions on farms. On this basis there are now millions more people in agricultural districts than agricultural, as compared with urban, income warrants.

Why this remarkable relatively large population on farms? Historical reasons might be cited, but perhaps there are two main causes—a phenomenally low standard of living in agricultural areas, and low per capita wealth production. It is evident that present agricultural income can maintain only a standard of living that is on the whole far below the average prevailing in cities. On the other hand, with a third of the national population producing less than 18 per cent. of the social

income it must be inferred that productional methods on the farm are much in arrears of those employed in city occupations. There remains, of course, the speculation as to the extent to which urban interests "farm the farmer." Feeble selling methods on the part of the farmer result in low prices for his goods and affect the total and per capita agricultural production as given in census reports. But even with allowance made for the superior profit-taking facilities of city occupations, it would seem beyond question that per capita production in the country is relatively low.

Evidently if more people enter farming, other things equal, the prices received by the farmer will fall due to overproduction and a still lower standard of living result. If more scientific methods of farming are employed, thus increasing agricultural production, prices will tend to fall unless there is an exodus of farmers or selling organizations among farmers to hold prices up. With a higher percentage of population going into farming and with more scientific methods the glut of farm products would be severe, unless relief were found in regulating the quantity of farm products raised for purposes of maintaining prices. The limited physical capacity of society to consume farm products is a fact to be taken into account.

Even if the prices of city commodities were greatly decreased and the prices of agricultural products increased, while the income to agriculture would warrant a higher percentage of population in the country, the absolute amount of agricultural products consumed by society would remain about the same for a given national population, assuming that no scarcity of agricultural products already existed. In the event of larger income to agriculture a larger relative population is conceivable only on the assumption that agricultural production remains about the same, possibly through the shortening of hours of labor by which overproduction would be avoided.

In response to economic laws the drift to cities may be expected to continue indefinitely. We must accept the fact that agriculture is not by any means the dominant occupation, but is relatively decreasing in importance, its logical precedence in the creation of values of course being conceded. But it would be unreasonable to urge a larger relative agricultural population without simultaneously urging organization among farmers to regulate production or to hold prices to a level which would enable them to approximate the standard of living characteristic of cities, unless cheap farmers are desired as well as cheap food. The arguments for a relatively larger agricultural production should not be *ex parte,* for such would prove the farmer's undoing if not refuted by protective efforts among farmers themselves.

THE EFFECTS OF SCHOOL LIFE UPON THE NUTRITIVE PROCESSES, HEALTH AND THE COMPOSITION OF THE BLOOD

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THE school is a formal agency devised for the purpose of bringing the child into possession of the main body of our social inheritance—the treasures of knowledge and skill laboriously accumulated by many generations of ancestors. When these treasures were few and pertained mostly to the affairs of immediate self-preservation, there was little danger of overburdening the young in the process of their acquisition. The intricacy of present-day civilization, however, is constantly increasing the difficulties which must be met and overcome by all who are not to become playthings of complex social and industrial forces. The period of infancy has not lengthened in proportion to the increased educational demands upon it. The school year has been considerably extended and for the first time in the world's history attendance has been made generally obligatory.

That this situation involves certain physical dangers to the child is self-evident. Indeed, the charge of school overpressure has been made repeatedly for at least half a century, though it is only recently that investigations of scientific character have been directed to the problem. Some of these are here reviewed, in the hope that further researches in this important field may be stimulated.

The Effects of School Life upon Growth

Schmid-Monnard sought to ascertain the influence of school life upon growth by comparing the growth attained during the seventh year of life by children in school with that attained by children of the same age who had not entered school. The results, as shown in the following table, indicate that school entrance constitutes a shock to the nervous system of the child severe enough to retard growth (15).

	Growth in Weight Expressed in Kg.		Growth in Height Expressed in cm.	
	Boys	Girls	Boys	Girls
Pupils not attending school	2.2	1.9	7.4	5.6
Pupils attending	1.5	1.6	4.2	4.5
Difference in favor of former	.7	.3	3.2	1.1

Engelsperger and Ziegler (4) measured about 500 children, five to six years of age on entering school and again two months later, and found that 20 per cent. had lost weight. This appears significant in view of the fact that the early fall is normally the season of most rapid growth in weight. The retarding effect was most marked in the youngest pupils, those under six years of age. The authors conclude that entrance before the age of six years should not be permitted and that in many cases it ought to be postponed until seven or eight.

Quirsfeld (14) followed the growth of 1,014 children through the first four years of school life and found that 46 per cent. failed to gain weight during the entire first school year, while 21 per cent. showed an actual loss. The number failing to gain during the second year was only 10 per cent., the third year 8 per cent. and the fourth year about 6 per cent.

The Effects of Prolonged Mental Strain upon the Nutritional Processes and the Composition of the Blood

One of the evils most often blamed for school overpressure is the formal examination. In 1896, Serafani found that examinations caused a marked reduction in the amount of nourishment taken by university students, and a corresponding decrease of weight. His conclusion was to the effect that prolonged examinations tend to bring about a condition of the nervous system resembling that characteristic of persons who are chronically neurasthenic.

Ignatieff (8) made a study of the physical effects of examinations on 242 pupils, ten to sixteen years of age, in a Moscow military school. The pupils were weighed just before they began preparation for the examinations, again at the close of the examinations, and finally after the close of the ensuing 3½ months of vacation. Comparing the second weighing with the first, Ignatieff found that 79 per cent. had lost weight, that about 11 per cent. had not changed and that only 10 per cent. had made any gain. Since the examination and the preparation for it extended over a period from one to two months, and since the pupils were at an age when growth from month to month is normally very rapid, all ought to have shown a gain. As it was, those of the lowest grade lost on an average 2 per cent. of their weight and those of the highest classes over 3 per cent. Quite different is the result when we compare the weight records before vacation with those after vacation, for here we find loss of weight with only 4.6 per cent. and gain with 90 per cent. For 13 pupils, however, the extended vacation was not sufficient to make up the loss of weight suffered during the strenuous pre-vacation period. Ignatieff concludes that in its physical effects the examination is comparable to a severe illness, and that a mental strain severe enough to cause such profound alterations in metab-

olism could hardly fail to affect unfavorably that organ most concerned in the overpressure—the brain itself.

Binet and Schuyten (2), by carefully weighing the quantities of food consumed by school children in the different months of the school year have been able to show that the child's appetite deteriorates as the school year proceeds. The exact causes of such deterioration are very complex and difficult to disentangle, but the basis, at least, for an explanation is to be found in such investigations as those of W. B. Cannon, Pavlow and others on the physiology of digestion.

Data of this kind lead us to infer that the nervous stimulation involved in excessive mental work produces its injury through such reflex effects as those upon the nutritive processes. Graziani, however, has raised the question whether in addition there may not be unfavorable influences more direct than this explanation assumes. He believes there are two such influences: (*a*) Imperfect oxygenation of the blood and incomplete elimination of carbon dioxide due to the superficial respiration proved by Mosso, Macdonald, Bush, Obici and others to result from application to mental tasks; and (*b*) an immediate effect upon the chemical composition of the blood corpuscles due to the accumulation of fatigue products resulting from mental work (5).

In order to test the latter theory, Graziani subjected 18 university students and 17 children of ten to twelve years of age to blood tests before and after the preparatory period for school examinations. The tests involved three determinations: the number of red corpuscles, the relative proportion of hemoglobin which they contained, and their power of resistance. In regard to the number of corpuscles, no constant differences were found either with university students or with children. The proportion of hemoglobin, however, showed a decided decrease, amounting to an average of 10 per cent. with the students and to nearly that much with the children. The effect upon the power of resistance of the red corpuscles was much the same as other investigators had shown to result from certain poisons. Graziani, therefore, concludes that in all probability mental work produces a toxin which brings about an immediate change in the chemical and functional properties of the blood.

To try this theory still further he subjected himself and a twelve-year-old boy to the same kind of blood examinations, except that in this experiment the blood tests were separated only by a number of hours of strenuous mental work instead of by many weeks, as was the case in the earlier experiment. Here, again, the decrease of homoglobin was marked, amounting on an average to 7.5 per cent. with Graziani himself and to 8 per cent. with the boy. Graziani believes that the underlying cause of school anemia, with its alterations of metabolism and its imperfect oxygenation of the blood, is to be sought in the influence of excessive accumulations of toxic products of fatigue.

Another important study of this type by Helwig (6) corroborates the findings of Graziani. This author made many blood tests upon himself and six other subjects for the purpose of determining the influence of school work, fresh air, rest, marches and lessons of different degrees of difficulty both upon the number of red corpuscles and upon their "degenerative" and "regenerative" processes. The study seems to have been made with the most approved technique and with the greatest regard for scientific accuracy.

The results were rather variable for the corpuscle count, but quite striking as regards the "degenerative" and "regenerative" processes.

As a result of school work the "disintegration-quotient" was increased 29 out of 33 times. The author holds that the study "distinctly" demonstrates that school work not only imposes a strain upon the nervous system, but that it produces a "destructive effect on the blood corpuscles." The numerous tables presented by the author show rather convincingly the influence of the following factors in determining the total condition: (*a*) the difficulty of the school work; (*b*) the length of the work period; (*c*) the frequency of the recitation intervals; (*d*) the amount of exercise and the access to fresh air.

Arduous mental work produces destructive changes in the blood, while recuperation causes the elimination of waste products and finally a more or less active regeneration of corpuscles.

Observation of the children also showed that external manifestations of fatigue invariably accompany the microscopical phenomena associated with this state.

It was not only from highly sensitive children that these reactions were obtained. The author observed the same phenomena in his own person after long-continued mental strain.

While a considerable degree of disintegration could be noted in the morning after several weeks of concentrated sedentary work indoors, accompanied by physical depression, lassitude and heaviness, this phenomenon disappeared, together with the subjective symptoms, after a walk of two hours. On another occasion the disintegration quotient increased considerably after four hours incessant work at the microscope prior to taking food and following a prolonged period of close application to research work, but decreased rapidly after two hours devotion to a totally different occupation and lunch taken in the open air.

Rest days showed an immediate effect in a lower disintegration quotient. Long and tiring marches produced only small degenerative values and were followed by rapid regeneration. During a day of mental work disintegration continually increases until late in the afternoon, indicating that this part of the day is least suitable for hard study.

The reverse phenomenon, the improvement which takes place in the composition of the blood as the result of a well-spent summer vacation,

has been dealt with experimentally by Borchmann and others (3). Borchmann gave blood tests to 19 boys and 18 girls of Moscow before a two months' "summer colony" outing, and again after their return. The second test revealed an average gain of nearly a million red corpuscles per cubic millimeter of blood and a marked increase of hemoglobin. This is set forth in the following table:

	Boys.		Girls.	
	Red Corpuscles per Cubic Mm.	Percentage of Hemoglobin	Red Corpuscles per Cubic Mm.	Percentage of Hemoglobin
Before vacation	3,884,000	73.1	3,760,000	69.6
After vacation	4,820,000	79.2	4,480,000	78.3

Borchmann also tested eight of the girls two months after their return to school and found that in three the number of red corpuscles had still further increased about a quarter-million per cubic millimeter, while in the other five there was a decrease of about two thirds of a million as compared with the second count. But in no case was the condition as unfavorable as before the vacation. The hemoglobin had in some cases decreased 5 per cent. below the second showing, had increased in others, but in all cases it surpassed the pre-vacation record. Lauch had already secured similar results for children of Geneva, and the work of both is strikingly corroborated by numerous blood tests of children who have been transferred from unhygienic conditions of the ordinary class room to the Open Air School.

The Effects of School Postures on Respiration

The effect of school occupations on the respiration has been studied experimentally by Oker-Blom (13) and by Badaloni (1). The latter secured kymographic records showing the amount of respiration in the upper part of the lungs resulting from different postures assumed in writing. In this way it was determined that the asymmetrical position induced an inflexibility of the upper part of the chest and a decreased depth of respiration in the upper part of the lowered side. Later Binet raised the question whether this may not be compensated by simultaneously increased abdominal breathing. In a second study Badaloni was able to show that no such compensation takes place. His records prove that the asymmetrical position brings a "remarkable decrease" in the expanding capacity of the upper chest. The symmetrical sitting posture, even when the sternum was allowed to touch the desk, showed a far less injurious effect. The author concludes, therefore, that it is the asymmetrical position, rather than the sitting posture *per se*, which is responsible for the school's evil effects upon the lungs. He believes that the school is in this way an important cause of tuberculosis.

In 1911 Oker-Blom (13) reports a similar experimental study of

respiration carried on with 25 pupils during different school occupations. The most marked difference found was that between the standing and the sitting respiration. The decrease in total respiration for brief sitting (3 minutes) was about 8 per cent., and for longer periods (12 to 39 minutes), 50 per cent. Interesting differences appeared with different kinds of school work. Knitting, for example, showed an impeding effect upon the respiration of the upper left lung 18 per cent. greater than did reading aloud. In agreement with the results of Badaloni, the greatest impediment to respiration was found in the upper part of the lowered side of the chest. This in turn aggravates the asymmetrical condition and helps to explain why scoliosis tends to run a progressive course. Oker-Blom concludes that all kinds of school activities, including hand-work, must be frequently alternated with change of position and with physical exercises if the danger of scoliosis is to be avoided.

The School as a Cause of Morbidity

Hertel's pioneer study (7) of the health conditions and work habits of 3,141 boys and 1,211 girls in the secondary schools of Denmark not only revealed what was then regarded as an incredible amount of physical defectiveness, but also demonstrated sufficient correlation of morbidity with years of school attendance and with daily hours of study to forcibly suggest a cause and effect relation. In the first two classes (children eight to ten years) 18.4 per cent. were suffering from one or more chronic defects serious enough to impair health. By the end of the third year the amount had risen to 34 per cent., and by the end of the eighth year, with its average of 8½ hours of daily study, to nearly 50 per cent. Especially significant is the fact that the pupils whose studies were chiefly of scientific nature showed a decidedly lower per cent. of morbidity than obtained among the students of classical courses, which make heavier demands upon strictly intellectual application and afford less opportunity for physical activity. Conditions were even worse among the girls, among whom morbidity rose rapidly from about 30 per cent. in the first two grades to over 60 per cent. by the age of 12 to 16 years. It is difficult to avoid the suspicion that the daily period of study, which increased concomitantly from about seven to about nine hours, may have been to some extent causally related to the increase in morbidity.

The later study of Schmid-Monnard (15) of 5,100 boys and 3,200 girls in the secondary schools of Germany confirmed essentially all the findings of Hertel, revealing in the upper grades a marked increase in frequency of headaches, insomnia and other nervous symptoms.

Roughly speaking, schools with both morning and afternoon sessions showed in the higher grades nearly twice as much morbidity as

schools with forenoon sessions only. This is shown in the following table.

	Morning Session Only.		Morning and Afternoon Sessions.	
	Average, Per Cent.	Maximum, Per Cent.	Average, Per Cent.	Maximum, Per Cent.
Total morbidity	25	39	50	74
Nervousness and headaches	13	28	25	62
Insomnia	1.	5	4	19

Both Hertel and Schmid-Monnard found that the percentage of morbidity rises considerably toward the end of the school year. Mortality, also, slightly increases for a brief period after school entrance, as does also the incidence of infectious diseases.

The most extensive and important single investigation of this kind yet made is that carried out by the Russian Department of Education, the results of which were reported by Khlopine in 1911 (10). This investigation was essentially a sanitary census of all the secondary schools of the Russian empire, carefully and uniformly carried out under the direction of the chief medical officer of schools, and including about 116,000 out of the 139,000 pupils enrolled. Its main purpose was to establish the incidence for age, grade, sex and type of school of the following defects: myopia, spinal curvature, nasal hemorrhages, headaches and nervous troubles.

Khlopine's data show that myopia is much more common in the upper grades than in the lower, in the larger cities than in the smaller, and in western than in eastern Russia. Spinal curvature increases about 50 per cent. between the first and the last school grade. Between the first and the seventh grade headaches double in frequency while nervous troubles increase nearly fivefold. Nasal hemorrhages, which are thought by some to be associated with the circulatory changes in the head which result from the act of reading, were twice as common in the classical schools, with their heavier demands for reading, as in the technical schools.

We can not here enter into a critical discussion of the above investigations. It is well to emphasize, however, that such studies have to deal with exceedingly complex factors whose respective influences are hard to separate. At the same time, the problems are very challenging to the biologist and physiologist as well as to the school hygienist, and are probably capable of being refined in such a way as to yield more positive results than we have yet had on this aspect of human efficiency.

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THE PHYSICAL BEETHOVEN

By Dr. JAMES FREDERICK ROGERS

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THE study of the parentage of Beethoven should cause the over-zealous eugenist to pause and ponder whether we as yet have sufficient knowledge of the conditions governing heredity for the passing of any save the most tentative laws toward the regulation of lives to be.

Beethoven's mother was consumptive, his father a sot, and yet, though his immediate ancestry promised so little, the great musician was a giant in bodily force, a marvel of sober mental power in his art and a profound thinker along other lines; tender and self-sacrificing in his family relations, and of lofty moral sentiment and practise. Erratic he undoubtedly was, but largely from the stress and distress of a hypersensitive organization, produced by his deafness and other bodily ailments.

Little is known of the ancestry of Beethoven. His grandfather, who seems to have been a worthy man, and well-to-do, was apparently of good physique and in excellent health. Besides being a musician he carried on a small wine business. His wife was not so steady. The wine shop was too great a temptation for her. She fell into intemperate ways to such an extent that it was found necessary to confine her in a convent. Their only surviving child came easily by his mother's bad habits, for "he was given to tasting wine from a very early age." His illustrious son often rescued him from the clutches of the police and helped him home, always with the utmost tenderness. He was never known to utter a bitter word about his father, and he resented any uncharitableness toward him on the part of others. His father lived until Beethoven was twenty-two. His mother, who is described as a pretty and slender woman, died, after a long illness of consumption, when Ludwig was seventeen.

The boy Beethoven was a lively little fellow, but more reserved and less boisterous than most at his age. He evidently had a goodly fund of animal spirits for, like all healthy children, he had a great dislike for sitting still, and it was necessary to drive him to the piano if any studying was to be done. His unfortunate father, hoping to produce a profitable prodigy—possibly another Mozart—began his lessons by the time he was four years old and kept him hard at work at them. Friends of

his youth told of how they had seen the boy standing on a stool before the piano, crying, as he practised. Pfeiffer, a teacher who lived with the family, after coming home with the father late at night from the tavern, frequently took young Ludwig out of bed, and kept him practising until morning.

In later youth, as events in the family produced their influence and as his mind began to go out into the realm of the spirit, he became quiet and reserved. He is described as a boy, as being short in stature, but muscular, "awkward, and with a snub nose."

With many conditions, including poverty, to depress his soul, and with apparently little to aid in his bodily unfolding, he nevertheless developed into a tremendously vigorous man—"the very image of strength," with a constitution that defied the attacks of disease and the influence of mental depression, for fifty-seven years."

As early as his seventeenth year he mentions being "troubled with asthma," which he feared would "lead to consumption." Very naturally he thought of such a termination since his mother died in this year. "I also suffer from melancholy which for me is almost as great an evil as my illness itself." Evidently it was his nature to be brave and buoyant, and it was this attitude toward life which constantly finds expression in his music. There is nothing sickly in his art.

But asthma was but the least of the dark demons of disease that came to dwell with him. At about the same time he had already begun to have symptoms of a depressing malady of the digestive organs which finally brought about his dissolution.

Worst of all, and before he was twenty-eight, there came the affection of the ears which speedily brought about deafness, the most trying of all his ailments. Already at this age this disease had so progressed that he was in mortal dread lest his infirmity be observed. After three more years he "found himself unable to hear the pipe of a peasant played at a short distance in the open air." His genius was fairly unfolding itself and was receiving the recognition of his contemporaries. And to be rapidly growing deaf! It is not to be wondered at that his melancholy became profound, and that only deep religious conviction and his ability to live in the glorious realm of the imagination, saved him from taking his own life.

Many doctors and more cures were tried for his deafness, but with no avail. In 1802 he writes: "For the last two years I have avoided all society, for it is impossible for me to say to people, 'I am deaf.'"

In 1802 his sense of depression reached its lowest during an acute illness, and his despair found utterance in the letter to his brothers, which is known as "The Will." He bewailed his exile by his deafness from the diversions of society which he had so loved; and lamented his seeming moroseness which this condition had brought about. The

contemplation of this affliction, he writes to his brothers, "brought me to the brink of despair, and had well nigh made me put an end to my life. . . . Recommend virtue to your children; that alone—not wealth—can give happiness. I speak from experience. It was this that upheld me even in affliction; it is owing to this and my art that I did not terminate my life by suicide."

From this time he seems to have become reconciled to the worst. There is in his letters little mention of illness for the next twelve years, and he was apparently in robust health. Nevertheless, disease was his constant companion and his deafness steadily progressed. In 1805 he was able to judge severely of the musical expression in the rehearsal of his opera. In 1814 he played his B flat trio. From 1816 to 1818 he used an ear trumpet. He continued to conduct his works, but in 1822 nearly brought the performance to ruin, although he was able to detect that the soprano was not singing in tune. Later in the same year he again attempted to conduct, but with such ill success that he did not try it again. This event meant so much to him that it marked another epoch in his life. From this time he was able to communicate with his friends only by writing.

The loss of his hearing undoubtedly had a most depressing effect upon his general health, and besides he was "constantly on bad terms with his digestive organs." His magnificent constitution was, however, as yet hardly touched by his continued ailments. In his collected letters there are from 1816 numerous notes to Archduke Rudolph begging ill health in apology for failure to keep his engagements as tutor to his highness. These are perhaps not to be taken so seriously as they sound, since he took little pleasure in his tutorship, though they indicate his continuous ailments.

In 1817 there are, however, letters to friends telling of his more serious illness. In June he wrote: "I caught a very severe cold which forced me to keep my bed for a long time and many months passed before I could venture out." After much drugging with powders and tinctures he is taking the baths at Heiligenstadt. He feels "that for several years [his] health has been steadily getting worse."

In 1818–1819 his health was much better and his devotion to the composition of his mass was extraordinary. Never had he been known to be so entirely abstracted from external things. It is to these years that the Ninth Symphony and the great Mass in D belong.

In 1821 he was laid up with a severe attack of rheumatism. He was at Baden for a part of the time and for some two years he was quite ill.

In February, 1822, he writes: "Last night I was again attacked by *ear ache* from which I generally suffer at this season of the year."

From 1823 on he was more or less continuously ill and under con-

stant treatment by baths and drugs, always hopeful, always finally worse.

In October, 1826, Beethoven, with his miserable nephew, visited Johann Beethoven at Gneixendorf. This niggardly man denied his sick brother a fire in his room, although the weather became severe, and the food he served him was not suited to Beethoven's disturbed digestion. They quarreled over the affairs of the nephew, and the composer packed his things on December 2 for a journey back to Vienna.

"It was biting weather, and even the winter sun seemed permanently hidden. A closed vehicle was consequently indispensable for a fifty miles' journey; the brother would not lend his, so with great misgivings Beethoven hazarded an open conveyance—a milk cart, it is supposed,—'the most wretched vehicle of hell' as the composer described it. . . . Beethoven, though only clad in summer clothing, resolutely faced all." It was a two days' journey and it cost him his life.

He took to his bed. Not only were his old ailments aggravated, but inflammation of the lungs set in. His nephew neglected to call a physician and none came to see him until three days after his return. Dropsy, the last symptom of his old abdominal ailment, appeared and on December 18 he had to be tapped. Again on January 8 and 28 the fluid had to be withdrawn. "Better water from my body than from my pen," he is said to have remarked. Malfatti, a former physician, was called, and under his care he improved, but only for a time. "His long, painfully long, end was now beginning. His constitution, powerful as that of a giant, blocked the gates against death for nearly three months." The end came on March 26, 1827, at the age of fifty-seven.

The physical Beethoven was a most impressive figure. He was not tall—was in fact, short,—not over five feet five inches, but with broad shoulders, and very firmly built. Siegfried said that "in that limited space was concentrated the pluck of twenty battalions." His head was large, with profuse black hair thrown backward and upward from a grand forehead; he had great breadth of jaw and somewhat protruding lips. His clean-shaven face was pock-marked from early youth, and browned and burned by wind and sun; his eyes, large and jet black, were full of the fire of genius, and were often remarkably bright and peculiarly piercing; his teeth were beautifully white and regular. His hands were thick and dumpy, with short, untapered fingers; his feet, small and graceful. On the whole his was not a handsome figure, "but the ugly pock-marked man with the piercing eye, was possessed of a power and beauty more attractive than mere physical charm." One person described him as "power personified," and another thought of him as a Jupiter.

Julius Benedict, who saw him in 1822, wrote: "Who could ever forget those striking features? The lofty vaulted forehead with thick

gray and white hair encircling it in the most picturesque disorder, that square lion's nose, that broad chin, that noble and soft mouth; . . . his thick-set Cyclopean figure told of a powerful frame."

His voice varied. "When quite himself it was light in tone, and singularly affecting; but when forced, as it so often was, on occasions of anger and temper, it became very rough and far from sympathetic."

In his later years, depressed by sickness or wrapped in his music, he grew careless as to his personal appearance, and even one of his admirers—the Countess Gallenberg—noticed that "he was meanly dressed, and very ugly to look at, but full of nobility and fine feeling and highly cultivated."

He was very regular about early rising, work and exercise, but beyond this he was singularly erratic in his habits. He was up with the sun, summer and winter, and worked from breakfast to dinner at two or three p. m. Dinner over, he immediately went, rain or shine, hot or cold, for his half walk, half run, into the country, or, at Vienna, about the ramparts. In his solitary life "Nature became to him a mother, sister and sweetheart." Neate said that he "never met any one who so delighted in nature or so thoroughly enjoyed flowers or clouds or any other natural object." "He was out of doors for hours together, wandering in the woods or sitting in the fork of a favorite tree." To Beethoven "every tree seemed Holy, Holy"; he exclaims: "No one loves the country better than I do," and "Oh! the charm of the woods,—who can express it?" It was in communion with nature in fields and woods that his inspiration flowed most freely into his sketch books. He worked as he walked: "As the bee gathers honey from the flowers of the meadows, so Beethoven often collected his most sublime ideas while roaming about in the open fields." He seldom composed in the afternoon or evening.

Schindler tells us that "the use of the bath was as much a necessity to Beethoven as to a Turk, and he was in the habit of making frequent ablutions. When it happened that he did not walk out of doors to collect his ideas, he would not infrequently, in a fit of the most complete abstraction, go to his wash hand-basin and pour several jugs of water on his hands, all the while humming and roaring, for sing he could not. . . . Then he would seat himself at his table and write; and afterwards get up again to the wash basin, and dabble and hum as before." On more than one occasion the water went through the floor and trickled from the ceiling below, with the consequence that the master was forced to move to other quarters.

Like most great men, the matter of food and eating was of little moment to Beethoven. It was sufficient for him if he derived from his meals ample energy for his work. "Wherefore so many dishes?" he exclaimed on one occasion. "Man stands but little above other animals

if his chief enjoyments are limited to the table." While absorbed in the composition of the Mass in D, he worked like one possessed, and at least once was so absorbed that he went without eating for twenty-four hours, and he "looked as if he had gone through a struggle of life and death." His irregular meals of badly prepared food, hastily devoured, would have damaged more perfect organs of digestion than those of Beethoven.

For breakfast he usually had coffee, which, like Brahms, he often prepared himself. He allowed sixty beans to a cup, and made it a rule, when he had company, of counting the beans for each cup. At dinner his favorite dish was macaroni with Parmesan cheese. He was very fond of fish and on Friday always had fish and potatoes. A plate of soup or some left-over answered his purpose for supper. His favorite beverage was fresh spring water, which he took in large quantities. He was no judge of wines and is said to have injured his stomach by drinking adulterated kinds. He liked a good glass of beer and a pipe of tobacco in the evening.

If erratic in his habits, it was chiefly Beethoven who suffered the consequences. He was singularly pure in his life,—but only from such loftiness of character could come such music.

The physical Beethoven is reflected in his art—all but his ailments and illnesses. These never touched his spirit. He was a Titan and his work was titanesque. Not only is there nothing morbid in his music, but it contains more of humor than that of any composer. Beethoven remained physically robust to the last, notwithstanding his continual fight with disease. His afflictions only served to drive his soul farther into the realms of the ideal. His most profound utterances were poured forth in his last years, and, even in his last illness, "his overflow of fancy was indescribable and his imagination showed an elasticity which his friends had noticed but seldom when he was in health."

The examination of the wreck of that most powerful bodily machine showed the auditory nerves shriveled and degenerated, the liver, the source of his digestive disturbances, shrunken to half its normal size, and there were other signs of chronic disease, which, on slight grounds, has been attributed to syphilis. The convolutions of the brain were more numerous and twice as deep as usual.

So much for the Beethoven laid away at Bonn in 1827. The Beethoven of the Heroic Symphony—of the Leonore and of the Mass in D—is even more alive in all his inspiring strength and beauty than he was a century ago.

THE WORLD VERSUS MATTER

By WM. E. RITTER

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JUDGING from what one hears and reads, there is a great variety of opinion as to what sort of a thing the world in which we live really is. Indeed, so diverse are these opinions that one can hardly help wondering if we all do actually live in the same world.

A correspondent, unknown to me personally, writes that after having lived eighty years, he finds with every passing year and day the world becoming to him more marvelous and interesting; and this as the culmination of a career which seems to have been particularly well filled with affairs at arms, in business and of the intellect.

An artist friend is so laid hold upon by the glories of color and form that abound in each spot, new or old, in which she finds herself, that nothing could convince her that the essential frame and substance of the world is not beauty. Shift the motive of this type of person slightly, from that of delineative art to that of the discursive interpretation of nature, and you have the Jefferies, the Muirs and the Burroughs—the emotional naturalists.

Through many centuries and lands there has been the religious humanist who has taken to his soul the words "Behold, I have given you every herb-yielding seed, which is upon the face of all the earth, and every tree in which is the fruit of a tree yielding seed," and has rejoiced as he has repeated "And God saw everything that he had made, and behold, it was very good."

But alongside the radiant-faced religious humanist there has stood the sour-visaged religious ascetic, muttering:

> Hence lying world, with all thy care,
> With all thy show of good and fair,
> Of beautiful or great!
> Stand with thy slighted charms aloof,
> Nor dare invade my peaceful roof,
> Nor trouble my retreat.

And there has been, too, the sweet-voiced religious ascetic, saying:

> Ah, love, let us be true
> To each other! for the world which seems

> To lie before us like a land of dreams,
> So various, so beautiful, so new,
> Hath really neither joy, nor love, nor light,
> Nor certitude, nor peace, nor help for pain.

The outward gentleman who is an inward voluptuary, confides to you upon occasion that he is a "man of the world," and with the slightest encouragement he will let you know what "the world" is viewed from his standpoint.

The subjective idealist speaks without a qualification or misgiving about "my world," "your world," "his world"—how we, he and you and I create these several worlds.

"Nature is in reality a tapestry of which we see the reverse side. This is why we try to turn it," says a distinguished French literary critic.

A fact about these various worlds which comes out in bold relief when we place them alongside one another is the way they contradict, in some instances quite annihilate, one another. Perhaps the crowning instance of mutually annihilative "worlds" is the "all is flux" world of the Hereclitian philosophy, and the "no new thing under the sun" world of Ecclesiastes. And if any one is disposed to think this Greek-Hebrew world muddle is too ancient and outworn to be significant for us moderns, let him recall, on the one hand, the energeticers, to use a term that has gained some currency for designating a number of men high-stationed in the science of the present moment; and, on the other hand, those speculators who largely stake their scientific faith on a motionless ether.

The world surely does "speak a various language" to different persons. This can not be doubted. And there is much to justify the assertion of a German writer on esthetics that "Die Natur ist jedem ein anderes" (Nature is something different to every person). "Dem Kinde [ist es] kindlich, dem Gotte göttlich" (To the child it is childish, to the God, divine).

But is it really true that nature—the world—is through and through different to each person? Does each one create and possess his own world, and that in such fashion that these worlds have not in deepest essence, identical elements of uncompromising objectivity? Were I to attempt to answer this question to-night in terms that would fit well into the scheme of office furniture, so to speak, of either the professional scientist or the professional philosopher, I should soon empty this room, at any rate, if the company were to be more truthful than courteous in expressing its feelings as to the properties of such an occasion as this.

So what I say toward an answer to the query shall not be in the rôle of either scientist or philosopher, but rather that of the humble natural-

ist; or, as I prefer, natural historian. This means a descent from the dizzy perch of "the world" to the humble, particular things of which the world is composed. Or, expressed in the vernacular, it means "coming down to brass tacks." Exactly! Imagine, if you will, a representative emotional naturalist, a representative realist in art, a representative humanitarian religionist, a representative ascetic religionist, a representative "man of the world," a representative subjective idealist, and representatives of as many other types of world-viewing as you like, each one taking his turn in stepping, barefoot, on the upturned point of a brass tack. Is there anything in the result upon which they all agree? Note particularly that I do not ask, "Is there anything in the result about which they, or some of them, disagree?" Almost certainly there will be disagreement as to some of the details of the result; but these disagreements will not invalidate nor make meaningless the points on which they do agree. Very well, then, as to this experiment the general conclusion is that brass tacks are neither totally different nor absolutely alike, as interpreted by these several observers.

You will not miss my point: This rosebush in the front yard, that house across the street—is there the slightest disagreement among us, no matter how divergent our points of view, my ten-year-old boy friend, my man-of-the-world friend, my subjective-idealist friend, my artist friend, my Christian science friend, and all the rest, that this *is* a *rosebush,* and that that *is* a *house?* Does any one hedge or qualify in answering? Is or is not this a big rock on which we sit, an automobile in which we ride? Imagine yourselves, each one of you, under demand to choose in just three seconds between an unqualified "yes" and an unqualified "no" as an answer, the demand being backed up by a Winchester rifle leveled at your head. The first point to be gained in this is to see whether you will or will not *make the choice,* not to find what the choice will be. Either the "yes" or the "no" will save your life. What the demander is after is to find, first of all, whether or not you *can choose* instantly, when the issue is one of life or death. Having decided that, the question of what the choice is, is greatly interesting. Do you doubt that you would choose? And do you doubt that the "ayes would have it" unanimously? There is then, is there not, something about the world on which we can all agree? Is there not, in fact, a great deal about it on which we can agree when we come down to "brass tacks"; that is when common sense is appealed to, and life or death the issue?

I am speaking under the auspices of a scientific society to a more or less general audience. The occasion seems fitting, therefore, to raise the question as to what science is doing and may do toward finding what is solid in the world for all mankind—ground on which all may stand with equal unobstructedness of view for looking at the vast complex of things

we name "nature" or "the world." The way in which I have raised the question forecasts not only my belief that science has done and is doing very much in this direction, but also something of the methods by which I conceive this greatly-to-be-desired good may be still farther attained.

Do you remember how Christian on his journey to the Celestial City used to get out his roll in times of sore perplexity and read what was written therein? The Roll which, according to my doctrine, every successful pilgrim must have easy of access when the trail grows dim, the body weary, and hope and faith weaken while traveling the hard road toward his Fair View of the world, is Common Sense. Notice I do not say such a guide alone would take anybody anywhere. What I mean is that I do not believe anybody's Fair View is truly fair unless he does read in this Roll over and over again. And one of the things I want to hammer home to-night is that Section I. of the Roll is natural history—unostentatious, old-fashioned description, designation and classification of the myriads of objects by which we are surrounded: men and dogs, wagons and cows, trees and disease germs, clouds, rivers and birds, stars and mosquitoes, windmills and cherry blossoms, and all the rest.

I am particularly solicitous about this Section I. of the Roll because generous as is my recognition of what science is doing to help forward a better world view, and profound as is my faith that it will not, in the long run, be lukewarm or ineffective in this part of its mission, I am unable to be blind to the great neglect of this section in our day by many men of science, particularly those who are cultivating certain compartments of the realm of nature. And negligence in both fact and spirit of this first section (of clear description and designation) unavoidably entails considerable neglect of the whole Roll.

To make sure that my allegory is clear, I explain that it means that, according to my view, there are always currents in the sciences of external nature setting against common sense; and that in our era these seem to be particularly numerous and strong. Always in considerable danger of becoming sophisticated, science is specially open to this peril in an era like the present, when the momentum of its advance is so great that restrictions and criticisms leveled against it from the outside are hardly felt by it at all. It is doubtful if *internal* criticism in any great and well-established realm of knowledge is quite sufficient to insure its complete doctrinal healthfulness.

The particular form of sophistication which science is now suffering and against which pressure from the outside is, I believe, going to compel a reexamination and readjustment, is what is called, indifferently because uncritically, sometimes materialism and sometimes mechanism. A sharp distinction ought, I am sure, to be made between materialism

and mechanism. But I shall be true to my earlier promise and spare you a discussion so recondite as would be one that should undertake to establish this distinction.

What I am going to try to do is to show, briefly, that materialism held down to its legitimate meaning and made a general theory of the world is a form of scientific sophistication; and then especially, to insist that natural history is the natural antidote and prophylactic against such sophistication.

A young mathematical physicist, who I hear is highly regarded among his fellow workmen, tells me that one of the "fathers in Israel" of their science declares that physics is bankrupt to-day. Now I should not take this declaration, by itself, very seriously. Of the bankruptcy of science as a whole, and of particular branches of science, we hear rather frequently. But from some of the things this young friend tells me, and from what I gather from other sources—by conversation and the reading I am able to do along the edges of the domain of physics—I am led to suspect that there are conditions within that domain which justify considerable solicitude for the health of that science. My young friend's epigrammatic way of stating the situation is this: All nature reduces itself to matter, all matter to electrons, all electrons to ether, and all ether to a hypothesis.

Only a few days ago I heard a physical chemist making a sharp distinction between what he called the "world of fact," the world of common sense, and as he put it, "the world with which science deals." I submit that if such statements coming from within the portals of the physicochemical realm are to be taken seriously, if science as understood within that realm is not dealing with facts, then indeed are outsiders justified in taking seriously also the ex-cathedra statement about the bankruptcy of this science.

If then there really is cause for solicitude as to the solvency of physics—if it has used its credit (its speculations) well up to the limit of its assets (its facts), how has it come to do this, and how might it get back to a safe business basis?

Should any one question the right of biology, which science I represent, to inquire into the internal affairs of physics, the reply is that biology has heavy investments in physics both as depositor and stockholder, and so has not only the right but the duty to be informed as to physics' solvency or insolvency.

I believe physics and chemistry for years have been and now are violating certain principles fundamental and common to the right interpretation of nature in all its subdivisions. To return to the banking simile, these sciences have, unwittingly and unintentionally, invested their funds in inadequately protected securities. This I understand is a grave charge, and any one who should make it without being able to sup-

port it with unquestioned facts and the most painstaking argument ought to be looked upon as either a trifler, a charlatan or a well-intentioned incompetent. Since I do not court being listed under any of these heads I must state, as briefly as possible, the exact nature of the offense which, as I believe, physics has committed. Stated in the most general terms, it is against the natural history mode of viewing nature; or to carry the statement one step farther toward specificity, it consists in a violation of certain essential principles of observation, description, designation and classification which are so obviously the very foundation of the natural historian's "world." Or, expressed still more positively, physics has become over-mathematicized, and has concentrated its gaze too exclusively on a few attributes of what it calls matter, or substance. What I mean by being over-mathematicized is not that mathematics has been applied too widely or exactly to physico-chemical problems, but that the reasonings of pure mathematics, that is, mathematics as a purely subjective process and without reference to its application to objective reality, has been too exclusively relied on in the formulation of general theories. Not sufficient restraint in theorizing has been exercised, in view of the fact that the "probable error" involved in all physical experimentation contains two chances of error, the one wholly manipulative; that is, dependent upon imperfections of apparatus or methods; while the other, and from the present standpoint, far more important chance of error is that of undiscovered factors in the phenomena themselves which are being investigated.

A physiologist of deservedly great distinction has expressed the view that just as "the constitution of matter is the main problem of the physicist, the constitution of living matter is the main problem of the biologist." I want to call attention to the fact that "matter" with its connotations in the above statements is, historically, a poetic fancy; and further that it is merely a convenient symbol or fiction when considered from the standpoint of truly objective or observational science. Glance at the subject historically first. You hardly need be reminded that the conception of matter has come down to us from the ancient Latin poet Lucretius who sets forth his views with sufficient elaboration in his great poem "Concerning the Nature of Things"; and that he in turn got the idea from certain Greek philosopher-poets, more particularly Democritus. While Lucretius undoubtedly had much of the spirit of genuine objective science, no modern who studies his work and reflects on the influence it has had on subsequent literature and philosophy and science should forget for a moment that, as concerns methods and results of actual positive science, it was quite impossible for him to be more than mildly scientific; nor forget that his interests were primarily poetic rather than scientific. What he was aiming to satisfy was not so much man's observational and rational nature as his own emotional nature. His undertaking is well characterized by a recent writer in this way:

Lucretius and the Greeks, in observing universal mutation and the vanity of life, conceived behind appearance a great intelligible process, an evolution in nature.

This process was conceived to have its seat in a single homogeneous substance which was material rather than metaphysical; that is, in brief, was *matter*. The point to be particularly noted is that such a substance must be *behind* appearance; it must be a "hidden background"; it must be invisible. In other words the real world must be an invisible world. The obvious reason for this was that the visible world seemed too transitory and insignificant, and as regards men, too evil and worthless to satisfy the deeper longings of the poet's emotional nature.

Modern materialism has undoubtedly taken on a quite different motive from that which gave it birth, for no one would contend for a moment that the materialistic conception of the world in our day is primarily poetic. Its design is unquestionably rational and logical rather than emotional. Viewed historically this poetic motive of materialism has never met the needs in a large and general way, of the emotional side of human nature. The great epochal outbursts of poetic genius throughout the ages have been in one form or another quite the opposite of materialistic. The Dantes and Petrarchs, and Chaucers and Spensers, the Miltons and Shakespeares, and Goethes and Brownings, have been men with a strongly ideal or spiritual quality. The poets who by touching the hearts of men mightily have become their universal spokesmen have been of very different mould from Lucretius. Taking the facts which history actually presents to us, materialism as a poetic and philosophic motive has not been superlatively great; it has not met the deeper needs of the race.

What we now have to consider is whether modernized, that is to say rationalized, materialism is more successful. You will recall my earlier statement that science, like other fields of human endeavor, is rarely if ever capable of self-criticism to the extent of recasting, with no impetus from the outside, fundamental defects and errors into which it may have fallen. I believe science is now face to face with interests and demands from other quarters than its own that will compel a self-examination of its fundamental processes and conceptions, and then a recognition of what is in reality untenable in its materialistic theory of the world. This pressure, one hardly needs to point out, is being brought to bear from the sides of psychology, philosophy, religion and sociology. Summing up the whole situation, no candid observer can fail to acknowledge that the materialistic tendencies of the last twenty-five or fifty years have had something unmistakably brutish about them as regards the affairs of men. The doctrine of survival of the fittest has surely been of this character, and the so-called economic interpretation of human history and society, based avowedly to a considerable extent

on materialistic physical science, has been undeniably hostile to the nobler element of man's nature.

And so it happens that the inevitable reaction is appearing in such phenomena as that which in the political realm of our country is called the progressive spirit, strongly tinctured with religious zeal, and perhaps still more significantly in such mystical manifestations as Christian Science and Theosophy, and the far more soberly wrought out philosophical systems of Bergson and Eucken.

What now, we must inquire, is the fundamental difference between what I am calling the natural history mode of viewing nature and the materialistic mode; and wherein may the former be claimed to be more in accordance with the needs of what is best in man's nature?

The whole problem rests inevitably on the essential processes and composition of our knowledge of the world and can not be touched with the least prospect of success without due attention to what we call the *attributes* of natural bodies.

That these attributes are the common and ultimate ground of both the world itself and of our knowledge of it, is not only demonstrably true, but is truth of such kind that it needs no laborious demonstration except for minds that have become sophisticated by overstraining in trying to answer ill-considered questions. Common sense never strives after a single ultimate, invisible substance, either physical or metaphysical, in the orange *behind* the roundness, yellowness, heaviness, semi-softness, sweetness, juciness, and so on of it. Nor does science ever really demonstrate any such thing, however laboriously it may search for it. What it does accomplish is the resolution or analysis of the orange into innumerable constituent bodies, cells, nuclei, chromosomes and chemical compounds, solid, liquid and gaseous, chemical simples, electrons, et cetera. But—and here is a point of prime importance—each and every one of these bodies or objects has its own peculiar attributes exactly as the original orange had.

Scientific analysis of the objects of nature always runs in a two-fold stream: There are the analyses of the objects into constituent *objects,* and of stages into precedent *stages;* and there are the parallel analyses of these constituent objects into their attributes. Each and every object and grade of objects has its own attributes. These latter and these alone secure for the objects places in our knowledge. Now it so happens that all objects in the world as common experience finds them have many attributes never entirely attainable, so far as we can make out, or recognizable by any single one of our senses. We have an enormous amount of evidence to the effect that all objects of nature whatever possess attributes fitted to our senses of touch and sight at least. We have no well-established experience of any natural object having but a single attribute, or even a group of attributes appropriate to but a single sense.

Such is the indubitable testimony of all common experience and of almost all scientific experience. Right here is one of the strategic points of the whole situation. How trustworthy is the testimony of common experience and of so much of science as supports it in this matter?

Some physicists, how many I do not know, but seemingly a considerable number, do not feel themselves compelled to admit that there are no real objects in the world possessing but a single attribute. As I understand the conception of the electron as a corpuscle ("a little body" you note) of pure, negative electricity—of just electricity and nothing else—of "electricity with no material support" as some writers say, is virtually, though perhaps not admittedly, a natural body with but a single attribute. All ordinary experience is certainly to the effect that electricity is an attribute of *natural bodies* rather than a wholly *independent body*. The innumerable mechanisms all about us, batteries, dynamos, conducting wires, transformers, etc., for producing and handling it, are unequivocal witnesses to the truth of this assertion.

Before it can be admitted that electricity or the "ether of space" or any single entity with but a single attribute under any name whatever, is the real essence and explanation of the whole visible world, we must examine intently what would be involved in such an admission, and also the positive evidence advanced in support of the hypothesis.

First look at the matter for a moment historically or racially as one might say. One of the most significant results of modern anthropological research is the clear demonstration that the mind of primitive man is not clearly differentiated as to the way it recognizes objects in the world by which it is surrounded; that what is subjective and what is objective are very imperfectly separated in the primitive mind as compared with what they are in the mind of civilized man. Indeed the process of becoming civilized may be well characterized by saying that it consists in the gradual sifting out in consciousness of objective, sensible experiences from purely subjective experiences. The chief interest to us about this disentanglement of the human mind from the external world is that it consists, in large part at least, in discovering that what civilized men unquestionably recognize as attributes of natural objects, are held by primitive men to be independent entities on a footing with actual objects, that is, with objects composed of numerous attributes properly combined. The roar of the waterfall, the hoot of the owl, the destroying force of the storm, disease, hunger and the thousand and one other incidents of common life universally recognized by men under civilization as states or conditions of their appropriate objects, are conceived by savages to be independent beings. And it is clear that something of the same sort marks the development of each individual civilized man from earliest childhood to the full consciousness of mature life. In the terminology of biological evolution we have here an instance of the law

that individual development or ontogeny repeats in a general way race development or phylogeny. The designation and systematization and organization of sense impressions, on the one hand, and subjective states on the other, which are the very essence of rational life, and which distinguish the civilized man from the savage, and the adult from the child, are found on closer examination to consist fundamentally, as to fully one half at least, in naming and placing and correlating the attributes of natural objects.

Turning now from the racial and the individual development of ordinary rational life, to the development of physical science, we may characterize this development by saying that its whole course has been one of discovery of *new natural bodies* each having its own attributes; and of *new attributes* of old bodies, that is, of bodies already known.

The attributes of bodies, with many for each body, are the very cement and sand and gravel and steel out of which the reinforced concrete edifices of experiential knowledge, both common and scientific, are built up; and any one who comes forward with a hypothesis of nature which in essence declares that some single one of these building materials is all that nature really furnishes so that the edifice of knowledge must get along with only this one, is presenting a daring hypothesis sure enough. If true it must, of course, be accepted; but no one should fail to see that its complete acceptance would mean the complete demolition of the great edifices of common knowledge and physical science as these have been laboriously built up through the centuries, and the erection on their sites of other edifices wholly different in design and construction. Surely the proof in support of so revolutionary a hypothesis must be convincing beyond a shadow of doubt. Is it? For one I am convinced it is not. Were there no other grounds for doubting the electrical theory of matter and so of all nature, a sufficient one is found in the circumstance already alluded to, namely that no physical observation or experiment ever gets rid of the "probable error"; and that in this probable error there is always a chance of an unknown factor in the phenomena under investigation.

So I turn again to the natural history way of viewing the world and point out that it is in strict accord with both the historic development of natural knowledge and the fundamental processes of psychic life in that it accepts without cavil the whole range of attributes of natural bodies, demanding only that these be undoubted as to identification. It is only when the natural history attitude and the materialistic attitude toward nature is each viewed in its mode of treating the attributes of natural objects, that the fundamental distinction between the two attitudes comes to view. The natural history attitude is one of unreserved acceptance of the world of fact, one of its greatest concerns being to make sure of what the facts are. It makes no such sharp distinction between fact

and truth as materialism tries to make. Facts are the elements of truth much as chemical simples are the elements of chemical compounds. The critical natural-historian recognizes other differences than this between fact and truth but for the present discussion this suffices. All we need to do here is to insist that the cultivators of any domain whatever of natural knowledge who believe they see something in the nature of truth which makes truth's exaltation result in the degradation of fact, are moving over by just so much from the side of true science to that of subjectivism and mysticism, and that they are going *by the road of mathematics* makes no whit of difference so far as concerns the essence of the thing. I raise the question: Has mathematics any legitimate place in dealing with the objective universe beyond that of helping to "visualize" those portions of it too minute or too transparent or delicate for man's unaided senses? In other words, can it render any real service further than that of helping to make the description of nature more full and accurate and serviceable to man?

The natural history motive is not to "get behind" the actual world in the sense in which materialism would do this, but to get more deeply into the actual world—to move more and ever more of the world into the fold of real knowledge.

Scientific or rational materialism no less than poetic materialism is virtually a system of world-repudiation. The natural history standpoint, on the contrary, is the very antithesis of this, and looking at the two systems still from the standpoint of their treatment of the attributes of objects, we are able to see clearly wherein the materialistic standpoint can not possibly meet the needs of man's deeper nature while the natural history standpoint genuinely and unreservedly accepted and understood seems capable of satisfying these needs. In its determination to reduce all things to one or at least a very few simple material substances or forces and so to explain them, materialism of necessity makes the actual world subordinate to, or, as it sometimes says, a manifestation of these deeper essences and in doing this, of course, must subordinate the good there is in the world as well as the bad to these invisible simples; and when we look at what this means in the light of the part that the attributes of bodies play in the make-up of all our knowledge of nature, the real meaning of the statement made some pages back —that there is something genuinely brutish in materialism—becomes obvious. It means that the higher attributes of man's nature are never taken at their face value; they are nothing but manifestations of something lower down and more elemental in the scale of beings. The materialistic philosophy is always a philosophy of "nothing but."

The conclusion of the foremost protagonists in our day of the doctrine of the survival of the fittest and natural selection that the esthetic and religious attributes of men are merely by-products of their survival

and sexual instincts, is a conspicuous and remarkable illustration of this truth, and the so-called economic interpretation of human life and society is an illustration from a different angle of the same thing. From the natural history standpoint, on the other hand, there is no more question about the reality and validity and fundamentality of man's higher attributes than of his lower attributes, for it recognizes that the attributes of natural objects, being the very fundamentals of knowledge itself, never are, and seemingly never can be, reduced or explained by referring them to the attributes of other bodies lower in the scale. Its office is not to find something more fundamental and elemental behind attributes either high or low, but to make sure of the validity and generality of all attributes and then get them into a consistent scheme of classification. It, consequently, in the very nature of its procedure, has to fix upon standards of value and importance of attributes. It is in position to accept—nay, more, from the very nature of its undertaking, it must accept men like all other beings and objects in the full range of their natures.

But while I am emphasizing the belief that the natural history way of viewing the world is capable of meeting the deepest needs of man's nature, while the materialistic can not possibly do this, I would wish to make it quite clear that this is not my main motive, as a man of science, in defending the natural history standpoint. Primarily, my position is, that the natural history standpoint is the only one that is in accord with both the historic development of natural knowledge and the fundamental nature of knowledge itself, as well as with the processes by which it is acquired. And I should like to establish the claim that when the scientific interpretation of nature is genuinely sound, as judged by its own undertakings and best interests, it will encourage in every way the fullest and freest development and expression and satisfaction of the whole gamut of man's nature consistent with the healthful coordination of all the independent parts thereof; that is, consistent with the whole of life, individual and social.

And this brings me to the focus of the evening's enterprise: The chance and the duty of natural history to beneficently influence the attitude of people generally toward the world—toward nature, man and society. You will not, I trust, have understood me to mean natural history in any restrictive sense. As I am thinking of it, it includes every aspect of knowledge that aims to find out in the most comprehensive and accurate way possible, the make-up of the world outside our own heads. The distinctive thing about it is not so much how far its knowledge shall reach, as is the character of what that knowledge shall be. The goal of its striving is not to understand the constitution of the *matter* of which the world is composed, but of the *world itself*. Physical geography, geology, mineralogy, oceanography and astronomy are con-

sequently no less provinces of natural history than are paleontology, botany, zoology and anthropology.

For the ends of general education, the study of natural history should beget the habit of mind of demanding the widest and exactest knowledge attainable touching any situation in life where decision and action are necessary; and it should provide the individual with a large fund of information, all so vitally correlated and intertwined as to give every faculty of the mind the greatest measure of sensitiveness and avidity for new knowledge and higher enjoyment. It should create a great complex of knowledge, the whole logical and rational substance of which should be penetrated through and through by a subdued emotional appreciation of the beauty there is in the great whole.

Such a knowledge would, perforce, hold the world in reverence even after all due regard were given to those portions of it which are unseemly and ugly and evil.

For the ends of scientific education and research, the study of such natural history would serve to counteract the tendencies toward sophistication which appear to be an inevitable concomitant of the rigorous mathematical treatment of such portions of nature as are amenable to these methods. Whatever the department of science to which any life may be dedicated, sufficient attention should be given to what is fundamentally involved in the elemental processes of observing, naming and classifying, to insure against the perils of ever forgetting that these processes are really fundamental to all natural knowledge.

To attempt to banish these simple operations from the august presence of exact science because one may to a considerable extent carry them on more or less automatically and unconsciously is folly, sure and disastrous, no less than would be the attempt to banish one's feet from the act of walking or his hands from piano-playing, because these members may do their parts, after once being well schooled, with little or no attention to them.

THE AUTOMOBILE AND THE PUBLIC HEALTH

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SANITARY science has done so much towards the improvement of public welfare that it may not be surprising to credit the automobile with having contributed to produce some results. The question may be asked in what directions the public health is affected by the constantly increasing use of automobiles and autotrucks. A few considerations will make it apparent that horseless vehicles may bring about far-reaching betterment in human conditions. The enormous increase in the use of automobiles and autotrucks is bound to change some aspects of city life. There are possibly three directions in which the public health may be benefited, namely: (1) the improvement of streets and roads, resulting in reducing the amount of dust in the air, (2) the disappearance of the horse and horse stables from the neighborhood of human habitations and the consequent reduction of flies and (3) the avoidance of direct infections of stablemen and veterinarians, who come in contact with horses.

There are several reasons for the statement that improved street and road pavements will benefit the public health. Rough pavements offer opportunities for the accumulation of filth and dust. The stones, usually thought necessary for horses to get a good foothold, leave holes and crevices, where dust settles and the washings of streets from rain, snow or the sprinkling cart remain until dried out. The dry material is then dispersed by winds or passing vehicles and serves as means for carrying germs. Modern improved roads, with hard surfaces and sprinkled with oil instead of water, will prevent the rising of dust in large measure; sweeping of streets will become superfluous and the atmosphere will be purer and harbor relatively few microorganisms.

One of the most serious disturbances to efficiency of sewerage systems is the accumulation of dust, detritus and street sweepings, especially after rain storms. It is obvious that this trouble may be largely reduced through the improvement in pavements, which is advocated most enthusiastically by those interested in automobiles. Societies for road improvement are in existence to-day and the number is rapidly increasing. In some states of the union a goodly number of magnificent state roads has been built and although the movement is still in its infancy, there can be little doubt of the final outcome in regard to comfort and health resulting from the construction of good roads.

One of the missions of autotrucks will be the transferring of loading and unloading of freight beyond the city limits. The carrying of freight to warehouses on autotrucks will necessitate complete renovation of roads and construction of relatively dustless road beds. Incidentally this will also do away with much irritating smoke from locomotives. It has been stated that transportation of freight by autotrucks within city limits is economical both in time and expenditure. Improvement in city streets has followed in the wake of the introduction of electric street cars and the decreased use of horses in cities due to automobile traffic will increase possibilities in this direction.

The injurious influence of dust on the public health is of various nature. The mechanical irritation of the respiratory tract and the accumulation of dust in the lungs and eyes increase susceptibility to infections. Inflammations of the conjunctiva, due to infection with such common, usually considered innocent, germs as the ubiquitous hay bacillus, have occurred. Probably such infections follow mechanical irritation of the mucous membranes by dust or other causes. The hay bacillus is carried everywhere by dust. It must be remembered that dust is the carrier of germs—harmless as well as injurious ones. Bacteria, yeasts and molds rarely travel alone. They are generally kept in suspension by floating particles of dust. It is due to this fact that after snow and rain storms there are relatively few microorganisms in the air. Therefore any provision, which materially reduces the amount of dust will reduce the number of microorganisms in the air. Among such provisions improvement of road pavements takes a prominent place, since dust in the air can come only from the ground by the action of winds or moving vehicles.

The diseases which may be communicated by dust are manifold. The germs of pneumonia, various forms of tonsillitis, diphtheria, croup, whooping cough, colds and tuberculosis are undoubtedly carried by dust. In fact, probably all infections of the respiratory tract may be carried in this fashion. Germs of the diseases named have been isolated from the air. The germs of tuberculosis are carried chiefly by the sputum of affected persons and communicated either by inhalation of dust or by food on which germ-laden dust is deposited. It must not be understood that this is necessarily street dust, but no doubt street dust is a contributory factor.

Diseases of the intestinal tract may also be communicated by dust. Food and water, if contaminated with sewage, are the commonest vehicles of infection in typhoid fever and dysentery, but it is quite conceivable that some cases of obscure origin may be the result of dust inhalation or ingestion of raw food on which dust has fallen. Studies of typhoid fever epidemics have led sanitarians to recognize that food and water do not account for all cases and sometimes disease may be due to

contact infection or inhalation of infected dust from the air. The infection of the saliva may then enter the system through the tonsils or the alimentary tract.

The skin of man and animals is constantly infected with many germs, some of which are responsible for boils and abscesses, erysipelas and certain diseases caused by molds or mold spores and yeasts. Dust is a factor of importance in carrying these disease germs to a place where they can invade the epidermis and bring about results which may become serious. The germs settle on the skin and await the first opportunity for multiplying at the expense of the tissues. Cleanliness is a far-reaching preventative and reduction of dust in the air promotes cleanliness.

One of the greatest benefits which will result from the increased use of horseless vehicles will be the disappearance of horses and horse stables from cities. This may not appeal to lovers of horses, but sanitary and preventive measures can not be carried out without sacrificing certain emotions. The germs and spores of lockjaw are common inhabitants of the intestinal tract of horses. Dust from dried horse manure may become the immediate cause of this dreaded and fatal disease. The spores of lockjaw germs are highly resistant and may live in the air and carry infection for months. A small amount of atmospheric dust entering a casual wound may result in serious diseaster, since a considerable portion of atmospheric dust is really dried horse manure. Another much feared disease is glanders or farcy. Horses are especially susceptible to this disease which causes a discharge from the nose, frequently looked upon in the initial stages as a cold. Carelessness may result in contact with this discharge which carries the virus and by means of abrasions of the skin of the stableman, rider or veterinarian the infection may be communicated. Glanders usually terminates fatally. Cases of this nature are by no means scarce. Both lockjaw and glanders will become less frequent with the disappearance of horses from our streets.

In some states and municipalities war has been declared upon the fly. There are at least two species of flies which interest us in this consideration, namely the house fly and the stable fly. It has been recognized that flies may carry disease germs and thus become important factors in spreading infection, not to take into account the discomfort, caused by flies, to man and animals. In *The American Journal of Public Health* of December, 1913, is reprinted part of an article of the September number of the Department of Public Safety of Rochester, N. Y., giving some interesting figures on manure production and its relation to the fly problem.

Please note!

There are 15,000 horses in the city. The average output of each horse consists of thirty pounds of manure and eight pints of urine per day. It means that the 15,000 horses deposit on the streets and in the stables of Rochester over 82,000 tons of manure annually. The total manure output of the city would

make a pile covering an acre of ground 175 feet high. If every pound of manure exposed furnished a breeding place for 100 flies, then we should have, as a result of this large pile of manure 16,400,000,000 flies. We can no longer rely upon the slogan "Swat the fly," and we must get rid of the fly by starving it. We must clean up, so that there is nothing upon which the fly may feed; no decaying material in which to lay its eggs. "Starve the fly," must be the slogan. It is almost enough to make one give up hope and conclude that the automobile is the only solution.

The campaign against flies is based on study of the life history of the fly. These studies have demonstrated that manure is one of the commonest places for fly breeding. A comprehensive book on this subject has been published by Edward H. Ross, entitled: "The Reduction of Domestic Flies." Some of the following statements are taken from this book.

The house fly breeds in all sorts of filth, but stable manure is the commonest lair for the insect. The female fly likes to lay her eggs here and in horse dung the fly maggot or grub lives for five days and then becomes the chrysalis or nymph. After about five days more the fully developed insect emerges to become a nuisance and do its deadly work. Fly reduction is a beneficial measure because it brings about a saving of life; reduces sickness, sorrow and misery; results in riddance of a pest and facilitates sanitary inspection. It has been estimated that one fly can produce in one month 506,250,000 offspring. Supposing only one half of these survive the larval stages, we have the enormous total of 250,000,000 increase per month.

The author of this book also states that "In the West End of London the stables and mews have become garages and there are only a few flies, where formerly thousands pestered, . . ." The disappearance is due, in part at least, to the removal of the horse manure and with it the favorite breeding places for flies. The campaign against flies, therefore, consists largely in prompt disposition of horse manure. That the most efficient method of disposition is the removal of the horse is obvious and with the advent of horseless vehicles the horse becomes superfluous. Considerable success has already crowned efforts in caring for the excrements of horses and the banishing of horses from our streets will facilitate this work. With the consequent reduction of flies we shall rid ourselves of a disgusting pest and aid in the preservation of life, health and happiness.

Evidence of the rôle played by flies in carrying infection is not wanting. In the Spanish-American war much of the typhoid fever was ascribed to the presence of flies. They were so common that, when cooked food had cooled sufficiently, it was covered with flies. When eating the men had to keep the flies away with one hand. Fecal matter in the pits was covered with lime and the white specks from the feet of flies could be traced on food. Virulent tubercle bacilli, the germs of typhoid fever, of bubonic plague, of anthrax and of Asiatic cholera have been found on the feet or in the intestinal canal of flies. Infection of

milk by flies is a common occurrence. Hundreds of bacteria have been counted on the feet of flies caught in the cow stables.

Some sanitarians believe that many infant lives would be saved if the fly could be kept away from the baby's milk. A recent investigation in New York City carried out by Dr. Donald B. Armstrong (published in the *Journal of the American Medical Association,* January 17, 1914,) seems to show that there is some connection between flies and infant mortality. The author's results seem to indicate that the fly is a much neglected factor in the etiology and transmission of summer diarrhea. He thinks that greater attention should be given to the elimination of the insect by all those interested in prevention of infant mortality. Two areas were covered by his investigations, both practically alike in population and other conditions. The first area was subjected to every possible precaution against flies. The means were educational campaign, exhibition of picture films of flies in a nearby theater, screening of the 1,700 doors and windows, and placing of large fly traps in the courtways, yards and stables. The second area was permitted to pursue its usual insanitary course. In the protected area the total days of sickness of diarrheal diseases among infants was 273, in the unprotected area 984.

According to Farmer's Bulletin 540, U. S. Department of Agriculture, the stable fly, also known as the wild fly, the straw fly and the biting house fly, commonly breeds in horse manure, especially if straw is present, as is usually the case. It has been believed, although lacking confirmation, that infantile paralysis and pellagra are communicated by this species. It has been more definitely demonstrated that this fly is instrumental in spreading some diseases of domestic animals. Aside from these facts it is a tormentor of live stock. Horses and cattle suffer more than other animals, but sheep, goats, hogs, dogs and cats are known to be infected by these flies. Even man is not immune. A tropical disease of camels, horses and cattle, known as "surra," is communicated by this fly. Anthrax, glanders and possibly other diseases of cattle, also communicable to man, may be transmitted by the stable fly. Although the chief breeding places are straw stacks, the manure piles commonly found near stables where horses are kept furnish suitable breeding places. Adult flies may follow for considerable distances traversing roads and, when engorged with blood, settle on nearby objects. Other teams passing along the same highways are subsequently attacked. It is evident that with the reduction of horses and horse stables this pest will be greatly reduced.

Flies do not generally act as intermediate hosts in the transmission of disease. Usually they carry the germs on their feet or in the intestinal tract and infect food by walking over it or dropping on it. The danger from flies is greater than from mosquitoes. The latter act as intermediate hosts and carry the virus of malaria, yellow fever and other diseases.

The germs of these diseases undergo a well defined cycle of development in the body of the mosquito. For mosquitoes to become a menace it is necessary for them to bite a human subject suffering from malaria or yellow fever after which a period of incubation has to elapse before the bite of the insect becomes dangerous. This incubation period lasts somewhere from ten to twelve days. Direct infection by mosquitoes as mechanical carriers of germs is relatively scarce. Besides, mosquitoes are not universally susceptible to the diseases mentioned. Only certain species can act as intermediate hosts. Since flies are mechanical carriers the possibilities of infection by these insects is greater than by mosquitoes.

The probable benefits that will result from the increased use of automobiles and autotrucks may be summed up as follows: (1) With the universal construction of smooth and non-absorbent roads and the use of oil instead of water for sprinkling, the quantity of dust in the air will be reduced. As a consequence a number of diseases which are frequently transmitted by dust will be decreased and storm waters will be more easily cared for. (2) The horse will gradually disappear from our streets. With it the number of house flies and stable flies will be diminished; human lives will be saved and much added to health and comfort. Contact infections of those engaged in the care of horses will also become rare. At the same time out of door life and enjoyment will be encouraged and thus a further contribution to the betterment of human conditions brought about.

TROPICAL NATURE IN COLOMBIA

By Professor A. S. PEARSE

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FOR the naturalist reared in temperate climates the tropics will always be a promised land flowing with biological milk and honey. The medical men have been pioneers in opening up this *terra incognita,* though they were not the first to enter it. Tropical diseases are no longer looked upon with the dread characteristic of our grandfathers, but for the most part may be as well controlled as those of cooler climates. Though there is still a small element of uncertainty to add savor to tropical exploration, the naturalist of to-day may travel to the edge of an unknown country in a modern steamship and go forth to discover new things with a complete outfit of the latest scientific equipment—if he has the money to buy it. The tropics are the same as when Bates braved the terrors of the Amazon, but modern commerce and modern medicine have made it possible to travel with more or less comfort, and such simple aids as fly dope, quinine, and mosquito netting permit one to penetrate regions which were impossible fifty years ago.

The present article attempts to describe tropical nature as it exists in northeastern Colombia along the northern end of South America, just south of the Caribbean Sea. The descriptions are based on observations made while the writer was a member of an expedition sent by the museum of zoology, University of Michigan, to explore the region about the old Spanish city of Santa Marta. This portion of South America offers unusual opportunities for zoological study on account of its diversity. A strip of sandy desert overgrown with giant cactus stretches along the coast and extends back into the interior seven or eight miles. Beyond this the foothills of the Sierra Nevadas rise; only twenty miles from the city the peaks attain a height of 8,300 feet above sea level. Many small streams take origin in the mountains and unite to make their way across the lowlands to the coast. Extensive mangrove swamps line the shores of the Cienaga Grande, a great lagoon into which several rivers empty.

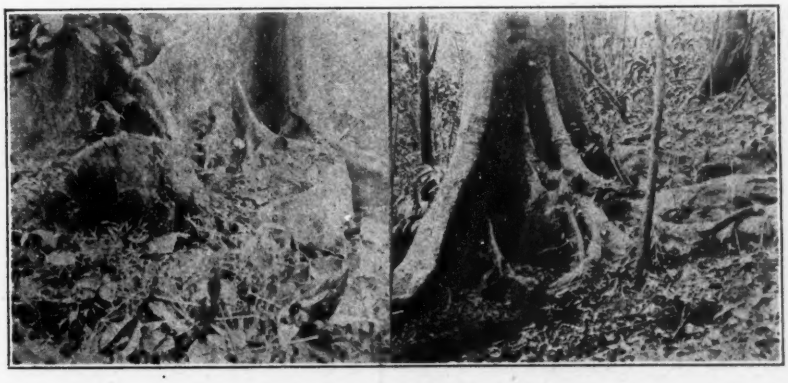
The members of the expedition were met as they stepped on Colombian soil by Mr. William A. Trout, the American consul at Santa Marta, Mr. M. A. Carriker, and Mr. O. Flye. These gentlemen and their families did everything they could to make our stay pleasant and profitable. The Colombian government was also extremely courteous, allowing our outfit to pass the customs without inspection.

STRANGLER TREES. The figure at the left shows a young strangler, that at the right shows an old one. The tree about which the latter wrapped itself was killed and has rotted away.

Starting the day after our arrival we rode eighteen miles into the interior on mule back to the Cincinnati coffee plantation, the home of Mr. Flye. That ride was wonderful! As we went higher the luxuriance of the vegetation increased and the trail often hugged the brink of a precipice where one could look for miles over the virgin forest and banana plantations below. Like the hunter in the "Lady of the Lake," we

> often paused, so strange the road,
> So wondrous were the scenes it showed.

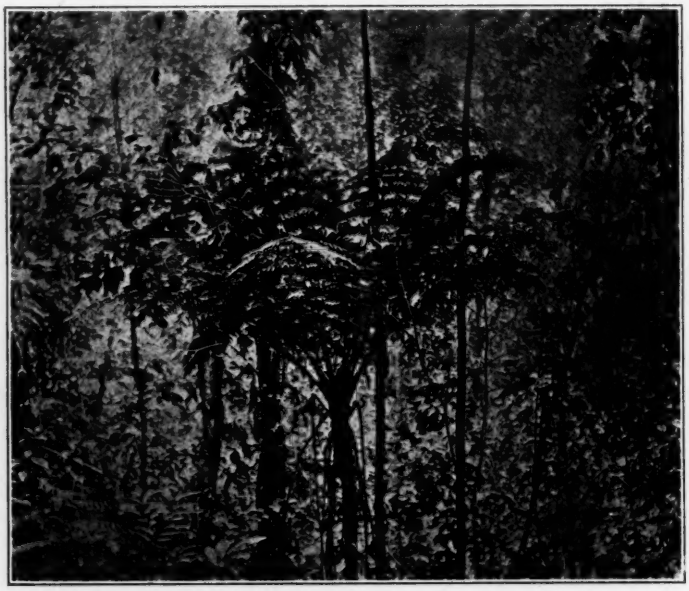
We lived at the plantation for a month in a clean little adobe house at an altitude of 4,500 feet. In half a day we could walk down to Minca, at about 2,000 feet, or up to the top of San Lorenzo, 8,300 feet. Beyond the coffee the tropical forest stretched away unbroken; in one direction to the desert along the coast, in the other toward the snow peaks at the crest of the Sierras. Every afternoon it was cloudy, usually there was rain.



BUTTRESSES.

The Tropical Rain Forest

Two things are noteworthy in comparing tropical forests with those of colder regions: the diversity of the vegetation, and the intensity of the struggle for existence. In the temperate or frigid regions of the earth which are forested we are accustomed to see one species or genus of trees dominate all other plants and become a "climax forest," *e. g.*, oak, pine, spruce, beech forests. But in the tropics conditions are favorable for many species; the growing season is always good, and the forest is always varied. Tree ferns, palms, vines, deciduous trees, epiphytes, mosses, ferns—all grow in riotous confusion. Vines climb over great



A Tree Fern.

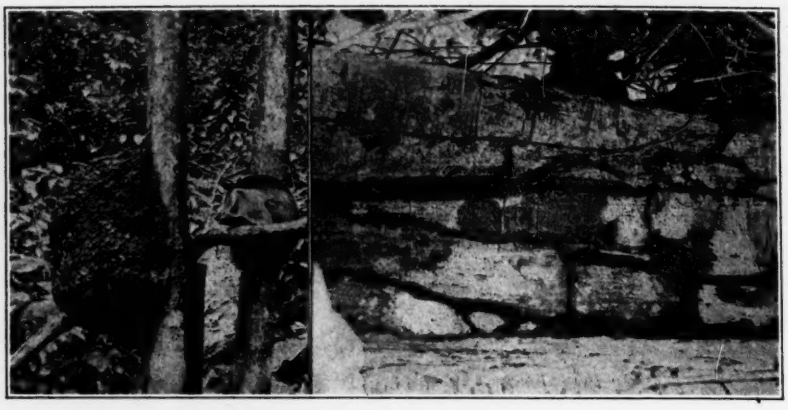
trees and steal their sunlight; strangler trees grapple with forest giants, squeeze them out of existence, and take their places; epiphytes and mosses festoon the limbs of trees, stretching their leaves toward the light that filters through the canopy above. Any handicap means that a tree must give way to more successful rivals, and many drop out. But the floor of the forest is not always strewn with the remains of the unsuccessful, for where it is not too wet the termites, or white ants, honeycomb every bit of dead timber and convert it into powder, which in turn is soon "resolved to earth again." Thus the cycle goes round and tree succeeds tree. One who lives in a temperate climate has no idea of the manifold intensity of the struggle among the plants in tropical forests.

In the midst of such a struggle one would expect to find a great variety of adaptations for surviving, and such is indeed the case. Many

trees have wide props or buttresses extending out from their bases which stiffen them against the fury of tropical storms. Some trees have thick bark which is scaled, or smooth, or ridged, or ringed, or spiny, or what-not; some scarcely have bark at all, but are smooth and naked. Palms not only grow in the conventional form, but many masquerade as climbing vines or epiphytes. Everywhere there is specialization and adaptation along many lines.

The humid shade of the forest offers shelter to many animals which, like the plants, show a great variety of adaptations. A large number of animals depend directly on the plants for food. The lowly termites are quick to appropriate any dead or diseased parts; vegetarian ants swarm everywhere. Long-tailed Kinkajous come forth at night to climb about in the mango trees; wood rats, squirrels and agoutis feed upon the luscious aguacates ("alligator pears"). Many birds have become specialized for fruit eating: flocks of gaudy parrots squawk among the trees, resplendent toucans wipe their great beaks against the limbs which have borne their repasts. In addition to these specialists many other birds eat fruit when it is available: trogons flit shyly here and there, and conceited motmots perch so that they may proudly wag their beautiful tails from side to side. Yet the denizens of the tropical forest do not appear gaudy and highly colored. A parrot is indeed a splendid object when you hold him in your hand, but stand below a mango tree and you are amazed to find that it is practically impossible to see any of the flock which are squawking noisily through its foliage. Only by watching carefully for movement can you pick out a bird here and there.

Besides the animals which hunt in the trees many wander about over the ground beneath. These are usually not brightly colored. Tapirs were common about the plantation, and one was killed by the workmen during our stay. These pachyderms had regular trails like cow paths through the forest. Droves of peccaries rooted in the ground and we often saw places where they had been feeding, but that was all. Mr. Flye told us how he had once been treed by a drove of these ferocious "wild hogs" which stood about and gnashed their teeth for a couple of hours. Jaguars and tiger cats hunted in the forest. One day a small boy brought us an armadillo. Agoutis were common everywhere. Once, while I rested at the fork of a river a great agouti came to drink fifty feet below. My Colt was at my hip, but I did not have the heart to shoot him—so much at ease was he, so self-contained, and so in keeping with his forest. He took his drink and went away, never knowing that a strange gringo had watched. Another time we saw a troup of big red monkeys swinging along through the tops of the trees, but they quickly scampered away when they spied us. We always went armed with gun or pistol hoping that we might bag one of the larger mammals, but fate was against us. The large animals are extremely shy and their colora-



A TERMITE'S NEST IN A TREE. Note the covered roadway passing down the tree trunk which bears the nest. The figure at the right shows the covered roadways of termites on a tree trunk.

tion makes them difficult to see. To secure them one must attend to little else. Our interests were not in big game, but we were well repaid with smaller fry—the forest filled our eyes, and notebooks, and photographic films to overflowing—yet never to satiety. There was always something new and interesting.

The forest swarmed with lizards, such as the little anoles and geckos, which crouched motionless or scampered swiftly after fleeing insects. Snakes lurked among the fallen leaves or climbed among the trees—gaudy coral snakes with their cross bands of red and yellow, the vicious fer-de-lance or bushmaster (called "*Ecke*" by the Colombians), big, but harmless, gopher snakes. Sometimes we met a "Bejuca" (vine snake)—the most curious of them all—never half an inch in diameter and attaining a length of three or four feet. But snakes were not easy to find. We rarely got more than two or three in a day, sometimes one, often none. Scorpions, tarantulas and other spiders abounded throughout the forest. Big land snails crawled on the trees or over the ground. Bright-colored butterflies fluttered in flocks through the open spaces. Probably the most typical forest vertebrates were the little tree frogs, which were abundant and various, and whose shrill piping was often the only sound to break the deep silence.

At night we took our jack-light (an acetylene lamp mounted on the front of a hat or carried in the hand) and sought nocturnal animals. On these excursions *Bufo marinus,* "the giant among toads," was always encountered. Another curious toad, a *Ceratophrys,* was dubbed the "snapdragon" by Dr. Ruthven on account of its fierce behavior. It would snap at us and grasp the end of a stick in its mouth, hanging on firmly while it was swung about in the air. Goatsuckers and bats often came right up to the light and flew about over our heads. Snakes were

active too, and we often flashed the light on one of them, hunting in the night.

Under fallen logs we found an admirable hunting ground for various invertebrates. Land crabs were often unearthed at considerable distances from the water. Centipeds of all sizes were abundant, some of them twelve to thirteen inches in length. Many millipeds and centipeds were found in their little nests where they lay eggs and rear young. Some of these nests were simple hollows in the soft pulp of rotting logs, others were carefully made dome-like structures formed from little pellets of mud. But the greatest find under fallen logs was the curious *Peripatus,* a primitive arthropod which resembles the segmented worms in many characteristics. These beautiful velvety animals glide slowly along, feeling their way with the two antennæ at the anterior end. If touched, they turn about and squirt two viscid threads from beneath the head. These threads, which harden quickly, serve to capture prey or entangle aggressors.

Termites were abundant in dry places everywhere up to an altitude of about 5,000 feet. They never come out into the light, but always construct covered galleries of wood-dust, dirt, excrement, etc., wherever they go. Some species live in the ground and build great mounds over old stumps and logs; others make mud nests on tree trunks from which they build galleries in various directions. These insects live in great colonies in which there are usually several enormous egg-laying queens and thousands of workers and soldiers. They eat away a piece of wood so that the interior is converted into a powder while the exterior is perfect. A log is thus reduced to a thin shell which crumbles at a touch.

Probably the most characteristic and interesting animals in tropical

TERMITE NESTS IN A FIELD.

A TERMITE'S NEST ON A DEAD TREE. Note that a woodpecker has made a hole near the top.

forests are the ants. Attention is at once attracted to the leaf-cutters which toil ceaselessly through the night and during most of the day, only intermitting their labors during the hottest part of the afternoon. These ants make big mounds, sometimes twenty feet in diameter, with numerous entrances. The underground galleries are continually extended and modified for there is an excavating party at each mound which carries little particles to a particular spot at some distance from the

FORAGING ANTS CROSSING THE TRAIL.

entrance where there is a dump pile. Other individuals of the colony are constantly moving along pathways in the forest carrying pieces of leaves. The same paths are evidently used for a long time as they may be six inches wide and worn (by the ants and rains) to an inch or two below the surface of the ground. An ant cuts a bit of a leaf, using his mandibles like a pair of scissors, and carries it into the nest. Here the leaf fragments are chewed into a pulp, spread out in beds, and planted with fungus. The sole food of leaf-cutters consists of fungus raised on vegetable pulp.

The driver ants go through the forest in great swarms cleaning up all the small live things as they travel. They have no home or perman-

In the left-hand figure the white mass is a fungus garden of a leaf-cutting ant. The thorns shown at the right are occupied by small ants. Note the small opening which leads into the cavity within each pair of thorns.

ent abiding place, but carry their eggs, pupæ and food with them. There is never any doubt when drivers are at hand, for all the sow-bugs, crickets, and other small creatures which usually hide in crevices are out in the open hopping hither and thither in frantic efforts to escape. The drivers we saw were small blind black ants which formed a veritable carpet over everything as they progressed. They covered the ground, searching every nook and cranny; they climbed each tree, slowly, methodically, carefully; they left no place unexplored; next day they were gone.

The foraging ants are somewhat like the drivers. They are larger and many individuals have great white heads provided with a pair of

IN A BANANA PLANTATION. Each tree is cut down when its single bunch of fruit is harvested, but new sprouts grow up from the root. 500,000 bunches of bananas are shipped from Santa Marta each month for New York.

enormous recurved mandibles. Like the drivers, these ants carry all their impedimenta with them. Those we observed always traveled in narrow columns which flowed ahead like living streamlets, branching out and reuniting over and over again. Foragers always appear to be in great haste and go scuttling along carrying pupæ, larvæ, pieces of dismembered insects, spoil from the nests of other species of ants, etc. We saw some foragers form long covered lanes with their bodies by clinging to each other with their mandibles and legs. Through these covered roads other individuals of the swarm scooted along—these were robbers carrying booty from the nests of other ants.

A BROMELIAD.

Many ants manufactured a sort of dirty paper from which they built hanging nests in trees. Others excavated logs like termites. One of these Mr. Gaige, our ant man, called the "spread-eagle nipper." This was a big black ant which opened its mandibles so wide that they stood out straight at the sides of the head, and then brought them together with a snap that could be distinctly heard at a distance of several feet. Woe to the unwary finger that was between those mandibles when they came together!

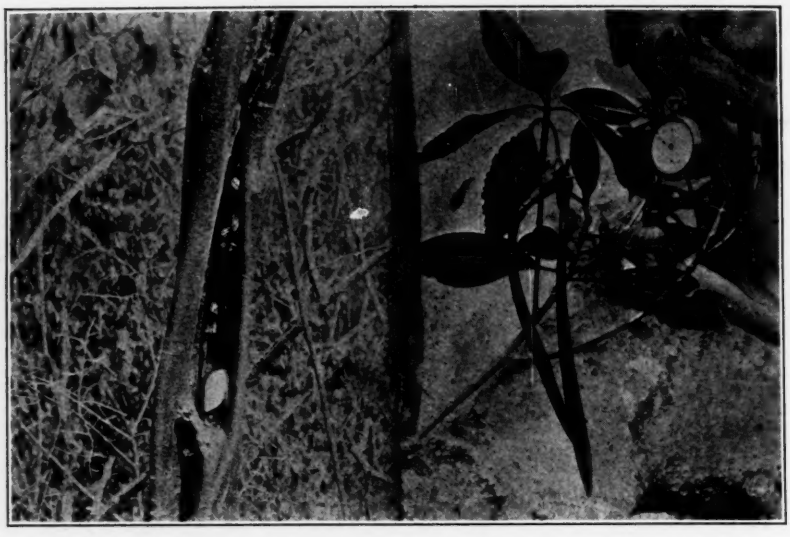
At Fundacion, a village in the forest beyond the banana country, we discovered two curious species of ants living in trees. One of these built little paper sheds over aphids which it put out to "graze" in the acacia trees. The aphids sucked the juice from the trees and gave out a sweet secretion which was taken from their bodies by the ants. The other species mentioned lived in little hollow thorns on the branches of an acacia. This tree was a true ant plant for it grew the hollow thorns in pairs with a little doorway leading into the cavity within them. The doorways were present in young thorns even before the ants had occupied them.

We can not pass the forest without mentioning the bromeliads. These plants are members of the pineapple family and are much like pineapple plant without the "apple" at the bottom. High up in the mountains they grow on the ground, but as the altitude grows less they begin to climb upward, and in the lowlands live as epiphytes in the trees. The bases of the leaves interlock in such a way that they make tight cups which act as reservoirs for the water that runs down from the tips of the leaves. The water contained in one of these plants frequently totals to two or three quarts, and the thirsty traveler is often glad to make use of it. Many small animals pass their lives in the shelter of bromeliads. We found tree frogs with their eggs, dragon fly larvæ, rat-tail (fly) larvæ, beetles, cockroaches, spiders, salamanders, and many other small animals. We tore open logs for two weeks and found only two salamanders, but got twenty from the bromeliads in a single morning.

The Desert

The strip of sandy country near the shore of the Caribbean Sea grows cactus and various xerophytic shrubs. Many of the cacti are thirty feet tall. Here the most characteristic animals are the ground lizards which swarm over the sand everywhere. Many of these are brightly colored with yellow or blue.

We were surprised to find land snails quite abundant in the desert. At the time of our visit they were æstivating in the crevices of curiously twisted trunks of the small acacia trees. Here also we occasionally found a land tortoise (*Testudo labulata*) wandering about among the cactus. Several streams ran through the desert. Near these the little



DESERT SNAILS AESTIVATING IN THE TWISTED TRUNK OF A DESERT TREE. MANGROVE SEEDS.

conical pits of ant lions often covered the ground so thickly that it was impossible to avoid walking on them.

Once near the sea we came across a great number of terrestrial hermit crabs, *Cenobita diogenes,* each encased in the shell of a land snail. The little army was moving slowly through a rocky portion of the desert where its members could sidle quickly from the shelter of one rock to that of another. These little crabs live a truly terrestrial life, and return to the ocean only once a year, when they breed. They apparently require very little water, for I brought three home with me and they have lived in a dish of dry sand in my office for more than six months. They have of course been supplied with food and a small cup of drinking water.

This desert, like those in other parts of the world, has a rather sparse fauna consisting of a few species, most of which are able to stand extreme desiccation, long fasts and great heat. The lizards and tortoises with their dry, scaly skins, the land hermits with thick exoskeletons and borrowed shells, the land snails with thick calcareous coverings, are all admirably suited to desert conditions.

BROOKS AND RIVERS

The streams on the northern Colombian coastal slope are easily divisible into two classes—mountain torrents and rather slow-flowing meandering rivers. From headwaters in the mountains the water rushes down over rocky beds for a time, then comes abruptly to the level sandy plain where much of its impetus is soon lost.

The most striking characteristic of the animals of the mountain torrents is their ability to hold on. The little catfish found there have a

free spine on the pectoral fins which enables them to cling tightly to the rocks; the caddis fly larvæ are all fastened firmly by threads; the water bugs are greatly flattened so that when they cling to a rock their bodies offer little resistance to the water. On the surface of the brooks enormous hairy spiders with ridiculously small bodies hunt for a living.

The tree frogs in the mountains were hard pushed to find a place to breed, for there was no standing water on the ground. They either carried their eggs on their backs or laid them in the bases of bromeliads. Many of the aquatic animals which are characteristic in other parts of the world are lacking in the mountain streams. There were no snails, pill bugs, or amphipods. The fauna was a specialized one—limited mostly by its ability to avoid being swept away.

In the slow rivers of the lowlands the most characteristic animals were the shrimps and prawns which often possessed greatly elongated claws. Curious little shrimps belonging to the family Atyidæ were quite common. These crustaceans have the first two pairs of legs modified into little brush-like forceps with which they scrape the microorganisms from the soft bottom or from aquatic plants. Many land and freshwater crabs lived along the shores of the rivers. Among these *Cardiosoma guahumi* was most conspicuous on account of its blue color and large size. This big crab digs holes in the mud beneath the trees near the mouths of rivers. It comes out at night seeking food and climbs the trees to eat the leaves. It was a great sight to watch hundreds of these crustaceans on the mud flats, sitting motionless in the glare of the jack-light.

Along all the streams below 2,500 feet there were many lizards of the genus *Basiliscus*. These animals have a very long slender tail and small front legs. When disturbed they stand nearly upright and run swiftly over the surface of the water, using only the hind legs and the tail, like the ancient dinosaurs. In the trees along the rivers we encountered many iguanas. These big lizards sit in the trees and if disturbed often

A Land Crab, *Cardiosoma guahumi*.

MANGROVES GROWING AT THE EDGE OF THE CIENAGA GRANDE.

dive from a height of thirty feet or forty feet into the water, swim underneath the surface to the opposite bank, crawl out and hide. We shot one iguana that measured 4 feet 9¼ inches in length.

SWAMPS

Many of the plants which are raised in hothouses or summer gardens in the United States are common weeds in Colombia. In the forest calladiums and cannas grown everywhere; umbrella plants line the shores of all the streams; in the swamps cannas and umbrella plants

THE FORD AT MINCA, AT AN ALTITUDE OF ABOUT 2,000 FEET.

constitute an important part of the flora. In some swamps there was a slender stemmed plant which had little white air bladders to keep it at the surface.

The jacana, a rail-like bird, is admirably adapted to live in tropical swamps. The greatly elongated toes enable this bird to walk with ease over the floating vegetation. Both sexes have a spur on the front of each wing which they use in fighting. A flock of jacanas is a beautiful sight as it alights, for every bird stretches its yellow-tipped wings as far upward as possible before closing them. Another swamp bird was a

GIANT CACTUS AND DESERT TREES.

species of tree-creeper which built a long bottle-shaped nest, which was constructed of thorny twigs in low shrubs. The eggs were placed in a little enlargement at the closed end and the long thorny entrance prevented snakes and other predaceous animals from entering.

The swamp water swarmed with aquatic bugs, beetles, snails and other animals. One large snail always climbed out of the water to deposit its beautiful rose-pink cluster of eggs on the stems of plants. Around the margins of the swamps there were many land crabs, snakes and peculiar engistomatid toads. Tropical swamps constitute an admirable habitat for many animals. The abundant vegetation and small animals fill the water with an organic network which supports many larger predaceous animals such as fish, herons, ducks, jacanas and snipe.

Mangrove Swamps

Mangroves are found only along the muddy shores of salt or brackish water in the tropics. These peculiar trees play an important part in land formation in such places for they keep growing farther and farther into the water and the accumulation about their roots makes new land. They are admirably adapted to live in mud flats. Roots branch out from the trunk in every direction and keep it upright on the soft bottom. The seeds germinate before they drop off, each forming a long spike-like root which penetrates the mud so that it is not washed away after it falls. Roots are sent along just beneath the surface of the mud and many small aerial rootlets grow upward from these which enable the

Mangrove Swamp. Prop roots support the small tree in the foreground and are growing down from the large tree further back. Many aerial roots are sticking up from the mud.

mangroves to survive in the salty water of the foul mud flats by absorbing substances from the atmosphere.

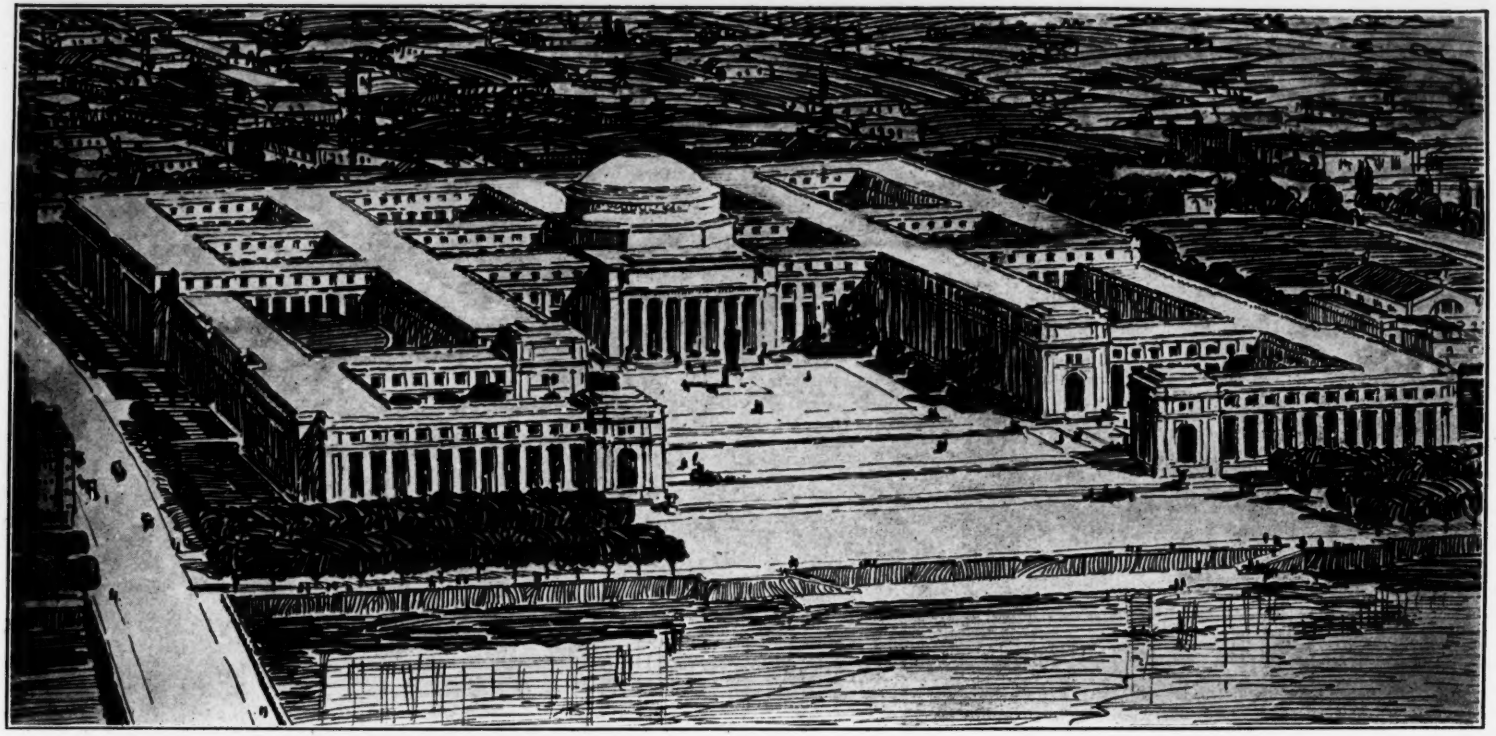
In the mangrove swamps along the Colombian coast we had a most exciting time. Mr. Trout towed our bongo (dug-out canoe) out on the Cienaga Grande, a large estuary, with his launch, and we spent several days at the edge of the mangroves. At night we were obliged to pull out into the middle of the Cienaga, for the mosquitoes were unbearable. One evening a vampire bat took the liberty of biting one of the party on the top of the head while he slept. Two of us had been hunting with jack-lights and on returning found him with his hair full of blood.

Often half a dozen of these little bats would settle over the roof of the boat after dark and compel us to move elsewhere to sleep.

Fiddler crabs swarmed among the aerial roots of the mangroves and Sesarma crabs climbed about over the prop roots and trunks. Crocodiles fished along the shore and the slapping of their tails was often the last sound we heard at night. Among the trees there were thousands of herons and many cormorants; sandpipers swarmed along the shores of the lagoons. Occasionally we met rarer birds, such as the beautiful roseate spoonbill.

Back of the mangroves along the shores of the Cienaga Grande we had our best jack-lighting. As the light moved along the eyes of the raccoons glowed like pairs of fiery cherries, now and then a deer crashed in the brush, and occasionally a big ant-bear lumbered away through the dark. Shooting at night is not easy. There is no target but the shining eye of an animal. Nevertheless, Mr. Trout shot a fine buck deer and a seven-foot crocodile. The former was hit in the center of the forehead, the latter, though shot from a canoe, was pierced cleanly through one eye.

In closing I must speak of my two companions, Dr. A. G. Ruthven and Mr. F. M. Gaige. It is no small test of friendship to be with two other men day and night for three months in a strange country. One has an excellent chance to become tired of his companions. But these gentlemen were so cheerfully unselfish in bending every energy to further the cause of science by making the expedition a success, so patient during the trials which always come in a tropical climate, that, though I had known and liked both for years, I came back home with increased admiration and respect for them.



SKETCH OF THE NEW EDUCATIONAL BUILDINGS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

THE PROGRESS OF SCIENCE

WORK IN ENGINEERING AT HARVARD UNIVERSITY AND THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE corporations of Harvard University and of the Massachusetts Institute of Technology entered into an agreement in January, according to which all work in mechanical, electrical, civil, sanitary and mining engineering will be conducted in the new buildings of the Masachusetts Institute of Technology on the site recently acquired by the institute on the Charles River embankment in Cambridge, not so very distant from the site of Harvard University.

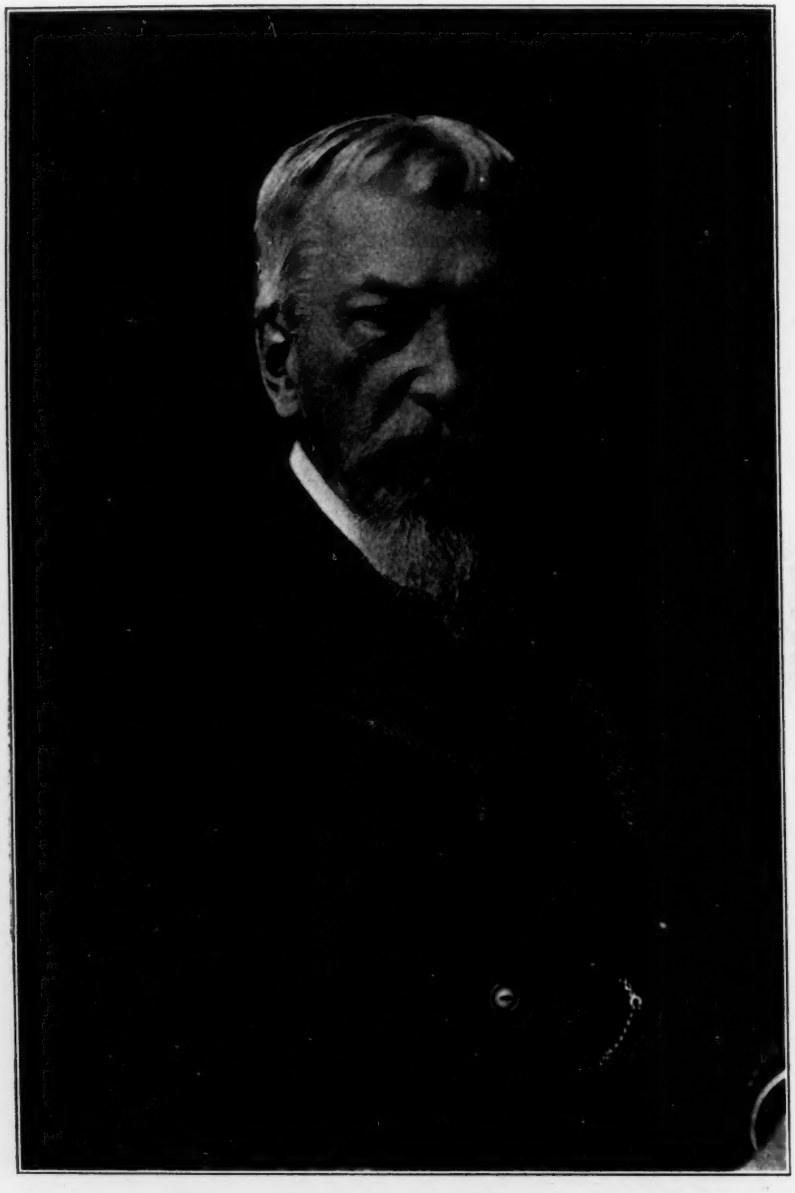
The university agrees to devote to the courses in engineering the income of the funds of the Lawrence Scientific School and the use of equipment not more urgently needed for other purposes, together with not less than three fifths of the Gordon-McKay endowment. This will provide at present some $60,000 a year, and may ultimately amount to more than $250,000. The institute devotes to the work all funds that it now holds for the purpose, and both institutions agree to use in future all funds acquired for the promotion of teaching and research in engineering. Buildings are to be erected only from the share of the funds supplied by the institute. All funds are to be expended through the bursar of the institute, but the corporation that supplies the funds is to prescribe the way in which they shall be expended.

All members of the instructing staff in the engineering departments referred to who give instruction in courses leading to degrees in both institutions are appointed and removed by the corporation that pays their salaries after consultation with the other corporation. The faculty of the institute is to be enlarged by the addition of the professors, associate professors and assistant professors in the school of applied science of Harvard University, and at the same time the professors of the institute receive the title and privileges of professors of the university. The president of the institute is the executive head for all work carried on under the agreement and is to make an annual report to both corporations. When a future president of the institute is to be selected, the president of Harvard University is to be invited to sit with the committee that recommends the appointment.

Students at the institute in the engineering courses mentioned are admitted to be candidates for degrees at Harvard University and have the same rights and privileges as students in the other professional schools. Students may receive degrees from either or from both institutions.

Both institutions are unaffected in name, organization and rights over their property and either institution may terminate the agreement on notice of at least five years, or a shorter period if mutually agreed on.

It will be remembered that some eight years ago the corporations of the Massachusetts Institute and Harvard University voted a plan of affiliation which was later abandoned owing, it was said, to the fact that the institute could not sell its present site for business purposes, though in fact the abandonment of the plan was due to opposition on the part of the faculty and



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DR. S. WEIR MITCHELL,

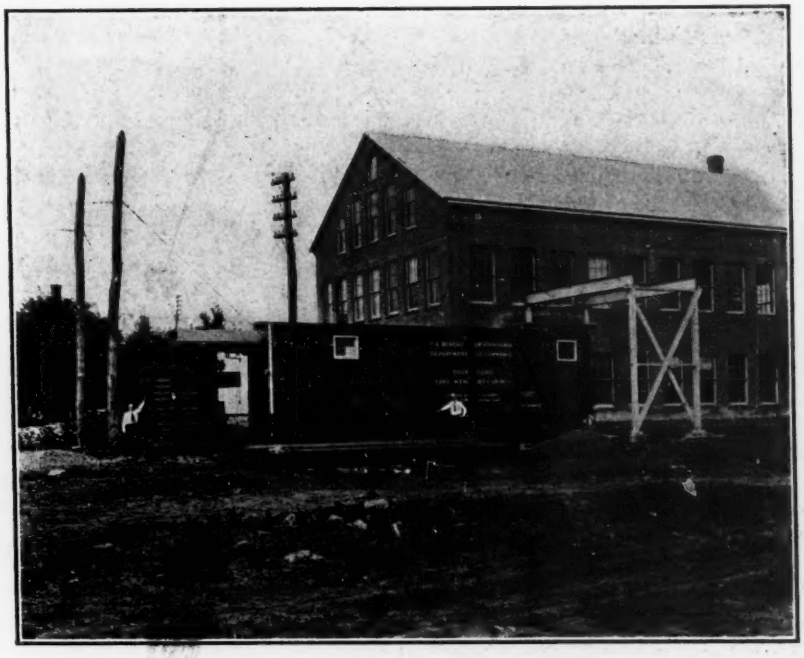
The distinguished man of science, author, physician and citizen of Philadelphia, who has died at the age of eighty-four years.

alumni of the institute. The former plan would have in large measure merged the institute in Harvard University; the present plan seems to use the funds of the university for the support of the institute. It may, however, be that both institutions will gain by the arrangement and both President Lowell and President Maclaurin emphasize the fact that educational institutions do not exist for their own glory, but for the welfare of the community as a whole, and that the combination of resources of the two institutions will provide a school of engineering at present unequalled in this country and perhaps in the world.

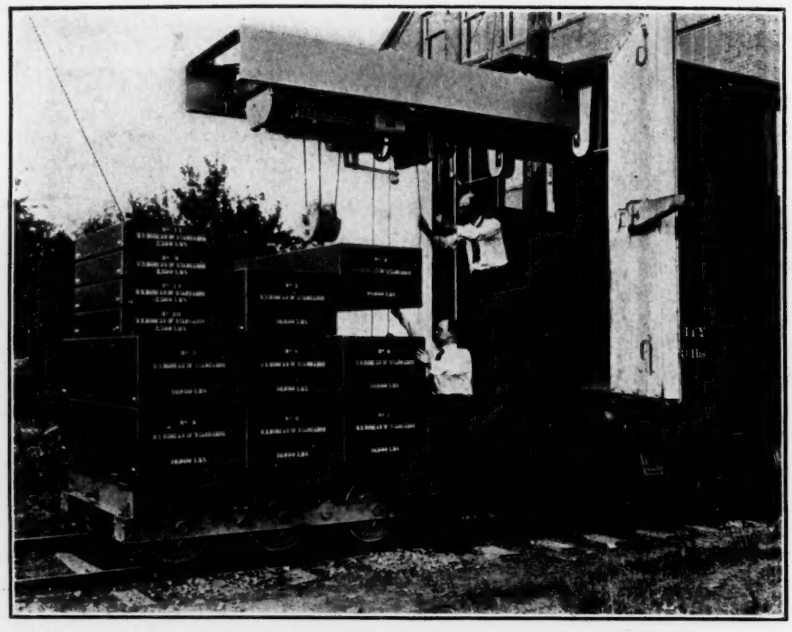
TRACK SCALE TESTING EQUIPMENT OF THE BUREAU OF STANDARDS

ABOUT four years ago the bureau began to investigate the subject of railroad track and elevator scales with the idea of standardizing them. It soon became evident that the greatest diversity of opinion existed among the experts regarding these subjects and that there was very little reliable information on the subject. In order to secure reliable data, and to be in a position to test large scales upon the request of the railroads, elevators, shippers or state officials the bureau secured an appropriation of $25,000 from congress last winter to purchase an equipment and to provide the necessary expenses for its operation. This appropriation became available July 1, 1913. The equipment was completed October 1, and over thirty-five track scales were investigated in Connecticut, Vermont and New York during the following six weeks. Throughout this whole period the car met with every expectation and is ready for further tests.

The car designed by the bureau differs radically from those ordinarily used by the railroads. The usual test-weight car is a heavy compact steel body with four wheels and a base of approximately six feet. It may weigh from 25,000 to 80,000 pounds and has



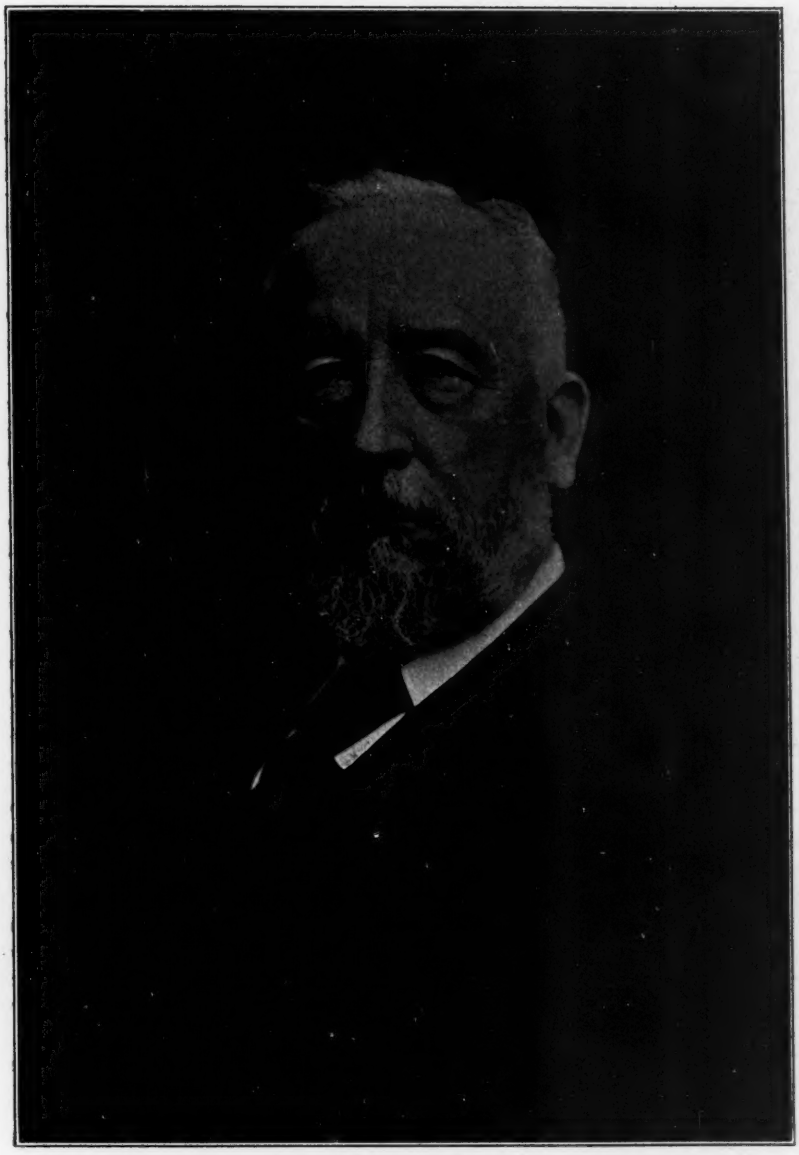
TRUCK SCALE TESTING EQUIPMENT.



THE TRUCK LOADED WITH WEIGHTS.

to be standardized on a master scale of the capacity of the car. Also since the wheels, brake shoes, air-brake connections, etc., are part of the standard weight such a car must be constantly checked on the master scale. This equipment is satisfactory for a railroad where the hauls from the master scale to the scales to be tested is not great, or where the operations are restricted to a single state, but plainly such an equipment would not answer the purpose of the bureau since it expects to send the car to all parts of the country, and it would not be possible to establish the necessary master scales at enough points to insure the correctness of the test car. The car of the bureau was therefore designed to reduce the wear on the equipment to a minimum, and this is accomplished by carrying a specially built, short, six-wheeled truck, and 100,000 pounds of standard weights inside a box car which is equipped with the necessary power to operate a crane for handling the truck and test weights. The test weights consist of eight 10,000-pound, four 2,500-pound weights and ten thousand pounds of 50-pound weights. The total error of the eight 10,000- and the four 2,500-pound weights is less than half a pound and since the large weights are bolted down to the floor of the car in shipment from one scale to another and are very carefully handled when used, there is no reason why they should change appreciably in a year. The same is practically true of the truck, which may, in a test of a 52-ft. scale with three different loads, travel about 300 feet or about sixty miles in testing 1,000 scales. As this travel would be at a very low speed, and without the application of brakes or the accumulation of dust or mud, it is hardly conceivable that its weight will change as much as five pounds in a year, an amount that would be insignificant in the combined weight of the truck and test weights. The truck which is operated by an electric motor supplied with current from a gasoline engine generator in the box car weighs 5,059 pounds.

Fig. 1 shows the general arrangement



Sir David Gill,
The eminent British astronomer, who has died at the age of seventy years.

of the equipment, while Fig. 2 shows a closer view of the truck loaded with seven 10,000-pound and four 2,500-pound weights, and the method of handling the weights.

In testing a scale the procedure is as follows: First, the box car which opens at one end is placed by a shifting engine five or ten feet from one end of the scale. Then the weights are unbolted, the gas engine is started and the crane is run out the open end about seven feet. Then the truck is picked up and set on the scale by the crane. This is followed by placing on the truck the necessary number of 10,000-pound weights to make up the desired first-test load. The truck is then moved over the bearing points of each section of the scale and the reading of the scale noted. The truck is run back to the original position and additional weights are added to make up the next test load, and the separate sections of the scale are again tested. This can be repeated until all the standard weights have been placed on the truck. If it is desired to go still higher the truck with its load of standard weights can then be run off the scale, the box car placed on the scale and weighed, the correction to the scale having been ascertained by the previous test. Knowing the weight of the empty car, the standard weights and truck can then be loaded, and the box car again placed upon the scale and weighed. In this way the scale may be tested up to approximately 175,000 pounds.

The general plan of the equipment is due to L. A. Fischer, physicist, Bureau of Standards, and to C. A. Briggs, assistant physicist, the whole being constructed by A. H. Emery, Stamford, Conn.

SCIENTIFIC NOTES

WE record with regret the death of Dr. Roswell Park, the distinguished surgeon of Buffalo; of Dr. George William Peckham, librarian of the Milwaukee Public Library, known for his contributions to entomology; of Dr. Edmund B. Huey, a student of genetic psychology, recently of the Johns Hopkins University, and of Mr. W. D. Marks, formerly professor of mechanical engineering at the University of Pennsylvania, later a consulting engineer in New York City.

COLONEL WILLIAM C. GORGAS has been appointed to be surgeon-general of the army of the United States, with the rank of brigadier-general.

THE fourth annual award of the Willard Gibbs Medal, founded by Mr. William A. Converse, will be made by the Chicago Section of the American Chemical Society to Dr. Ira Remsen, of Johns Hopkins University. The previous recipients of this medal are Professor Svante Arrhenius, Professor Theodore W. Richards and Dr. Leo H. Baekeland.

ARRANGEMENTS have been made for the establishment, as a memorial to Lord Lister in Edinburgh, of a Lister Institute.

THE General Education Board has given $750,000 towards an endowment of $1,500,000 for the medical department of Washington University, St. Louis, to create full time teaching and research departments in medicine, surgery and pediatrics.